SCIENCE ABSTRACTS.

Section A.—PHYSICS.

APRIL 1907.

GENERAL PHYSICS.

576. *Methods of Testing Iron and Steel.* **W. Ast.** (Report of Internat. Assoc. for Testing Materials, pp. 75–92, 1906. Extracts in Engineering, 82. pp. 637–638, Nov. 9, 1906. Metallurgie, 4. pp. 109–115, Feb. 22, 1907.) —The report embodies five papers. **W. Ast** gives results of macroscopic examination, static tensile tests, impact tensile and bending and static bending tests of notched specimens, and Korobkoff's bending test, and Brinell hardness test, of 55 heats of basic steel. It is concluded that Korobkoff's shock bending test of plain bars, and shock bending of notched specimens are more suitable for determining the quality of metals than either static tension or bending; and that the Brinell test is valuable for detecting lack of homogeneity. **Le Blant's** conclusions, from experiments on average steels and pieces that have not behaved well in manufacture or use, are that very brittle material is best treated in the form of round-notched shock *bending* specimens, very tough material as sharp-notched shock *tensile* specimens. Homogeneity is better studied by means of impact bending than by impact tensile tests. **E. Sauvage** obtained favourable views of notched impact tests from his experiments. **S. Rejtő** found a relation between the energy absorbed in notched impact tests and a plasticity number as determined in tensile and shearing tests. **H. J. Hannover** (Report, pp. 163–164) gives results of tests of malleable cast-iron steam, gas, and water pipes. The committee's conclusions and recommendations are in accordance with the experimental results of these five authors. F. R.

577. *Shear of Concrete, and Bond in Reinforced Concrete.* **A. N. Talbot.** (Eng. News, 57. p. 176, Feb. 14, 1907. From Bull. of the Engineering Experiment Station, Univ. of Illinois, No. 8. Abstract.)—The author gives the results of punching and double shear tests of concrete. With a concrete of limestone, the mixture being 1 : 3 : 6, and 2 months old, a shear strength of 1,100 lbs. per sq. in. is indicated ; a 1 : 2 : 4 mixture gave 1,300 lbs. per sq. in. These values are from 50 to 75 per cent. of the compressive strength, and higher values are expected with very pure single shear. The bond resistance in reinforced concrete was found to be from 350 to 450 lbs. per sq. in. of contact area for mild steel rods, 250 to 350 lbs. for rectangular rods, and about

150 lbs. for bright round rods. The ratio of slipping load to net surface of Johnson corrugated rods ranged from 400 to 625 lbs. **J. L. Van Ornum.** (Ibid. pp. 176–177. From Amer. Soc. Civil Engin., Proc. 32. pp. 972–998, Dec., 1906.)—Describes experiments upon small reinforced concrete beams which were repeatedly loaded and unloaded in a specially designed machine. The reinforcement was in the form of a single rod, which was in some cases pulled out, after about 50,000 repetitions of load; the bond then averaged about 125 lbs. per sq. in. of bond surface, as compared with 150 lbs. in fresh samples. Observations of the failure of bond are described in detail. It is concluded that rust on the reinforcement causes poor bond, and that if an excessive amount of water be used in mixing, a weak bond with the steel will result. F. R.

578. *Strength of Cement Mortar.* **M. Grübler.** (Zeitschr. Vereines Deutsch. Ing. 51. pp. 176–184, Feb. 2, 1907.)—In addition to tensile and bending experiments, results are described which were obtained upon specimens in the form of thick, short, hollow cylinders of 10 cm. internal, and 15 or 20 cm. external radius, and 10 cm. high, submitted to internal fluid pressure; the increase of circumference was observed by means of a mirror apparatus. These experiments, assuming different values for Poisson's ratio and for the ratio of the elastic moduli in tension and compression, give a tensile strength of from 36·67 to 40·74 kg./cm.², as against 46·6 in tensile tests and 31·5 to 39·6 in bending tests, for a 1 : 3 mortar. The measurements made upon the hollow cylinders gave excessively high values of the elastic modulus, whence either the measuring method was at fault (although careful trial indicated that this was not the case) or the distribution of stress was not as assumed for the purpose of calculation, owing to internal friction. Upon plotting the load-strain diagram for repeated loading and unloading, the permanent set in each cycle is made evident. F. R.

579. *Effect of Duration of Stress on Strength of Wood.* (Eng. Record, 54. p. 655, Dec. 15, 1906. Report of the Forest Service of the U.S. Dept. of Agriculture.)—It is found that a wooden beam can take twice as much deflection under impact as under ordinary rates of loading, without showing loss of elasticity. With different rates of loading in the ordinary testing-machine methods of compression and bending, very substantial differences are observed in the strengths indicated. The following table shows the increase of strength with increased speeds of loading:—

Minutes per Inch of Compression or Deflection.	Relative Ultimate Strength.	
	Compression.	Bending.
900	100	100
350	100·8	100·9
150	102·3	107·3
40	106·9	110·1
5	113·8	118·7

Tests are to be made to determine the effects of vibratory stresses on wood. F. R.

580. *Flight of Shot.* **A. G. Greenhill.** (Nature, 75. pp. 367–368, Feb. 14, 1907.)—In reply to questions by P. D. Strachan relative to the motion of the modern pointed, cylindrical form of shot *in vacuo* and in air, the author observes that a body projected in any manner in a field of gravity *in vacuo* will move so that the centre of gravity describes a parabola, while the body moves about the centre of gravity, so that to an observer seated there the body has the motion described by Poinsot, in which the momental ellipsoid rolls on a fixed plane. The normal to this plane is the axis of resultant angular momentum, and this axis preserves a direction fixed in space, while the body moves about it. When this axis coincides with the principal axis, the body appears to be spinning steadily about the axis, but a closer observation reveals always a precessional and nutational motion. The spinning of a body of perfect uniaxal symmetry accurately about its axis cannot be realised in practice, so it is better to consider the penultimate state, in which the spinning body, like a sleeping top upright, has steadiness almost perfect. With this limitation the axis of an elongated shot would move parallel to itself, on the whole, if fired in a vacuum; but if fired in air a couple arises as soon as the axis is oblique to the direction of motion, tending to place the axis of an elongated shot broadside to its motion and at right angles to the tangent to the trajectory; and this couple acting on the rotating shot will cause the axis to precess about the tangent. Even in the absence of air-resistance and gravity the resulting motion is of great complexity where the body is influenced by the stirring up of the surrounding medium. The problem defies analysis when gravity and air-resistance are taken into account; all we can say is that the frictional drag damps the nutation and causes the axis of the shot to follow the tangent of the trajectory very closely, the point of the shot being seen to be slightly above the tangent and to the right, with a right-handed spin. The axis will remain tangential to the trajectory during the whole flight, independently of any supposition or condition of shape and density of the shot, provided the spin imparted by the rifling is suitable, and that the trajectory is not curved too much. A. W.

581. *Thermodynamics of the Atmosphere.* VIII. *Relation between Wind Velocities and Atmospheric Pressures.* **F. H. Bigelow.** (Monthly Weather Rev. 34. pp. 470–478, Oct., 1906.)—Although the author uses the sub-title, "Meteorological Conditions associated with the Cottage City Waterspout" [see Abstract No. 190 (1907)], he does not refer to this subject at all, but returns to his Cloud Report of 1898–1899, and develops the equations for the velocity-pressure function. Formulæ and tables are given for the velocities in the c.g.s. and the kg.-m.-sec. systems, and conversion factors are added for dm.-gm.-sec., ft.-lb.-sec., and inch-grain-sec. units. The author proceeds to a review of the values assigned since Mariotte to the resistance-coefficient k for the motion of a solid in a fluid. For bodies of customary dimensions, such as plates, discs, spheres, &c., he adopts Schreiber's value, $k = 1{\cdot}30$; for raindrops Ferrel's $k = 1{\cdot}10$ should be used, but for hailstones the author would prefer 1·30. Reference is made to the equations of Poncelet and Unwin, which take account of the contraction and expansion of the stream lines on passing a body, to the whirling experiments of Hagen, of Thiessen and Schellbach, Thiébault, and Stokes, to the experiments of Recknagel, Schreiber, and Nipher on the distribution of pressure over a plate, to the equilibrium in the Dines machine, and other features. In the U.S., Robinson's cup anemometers are chiefly used, and their indications reduced by 20 per cent. H. B.

582. *Snow Thickness in Central and Northern Sweden.* **J. Westman.** (Ark. för Mat. Astron. och Fysik, Stockholm, 3. 3. pp. 1–32, 1906.)—The thickness of the snow layer on the surface was measured, so far as possible both on open ground and in forests, in the years 1903 (or 1902) to 1905 during April and May when the snow was melting, chiefly at eight stations, latitudes 59° to 68° 25′ N.; at Vassijaure, the northernmost station, observations were also made in July, 1905, at altitudes between 450 and 900 m. The thickness is measured at 3 or 5 points about 1 m. apart; some of the sites are on slopes. The influences of evaporation of the snow and of condensation of water vapour on it may be neglected. When the snow layer is diminished to 10 cm. and less, melting from below helps the melting from above. The water is first retained when the melting begins, and the snow turns grainy. At Vassijaure the density of the snow in a snow layer of a thickness of 112 cm. at heights of 105, 90, 75, 60, 45, 30, 15 cm. above the surface was found to be, in July 1905, 0·562, 0·579, 0·592, 0·606, 0·592, 0·600, 0·656; the maximum diminution of the thickness in 24 hours was 19·5 cm. Some remarks on the glaciers of the Sulitelma and Ålmajalos are added. H. B.

583. *Moisture from the Clouds on Table Mountain.* **R. DeC. Ward.** (Science, 25. p. 315, Feb. 22, 1907.)—Marloth has studied (S. African Phil. Soc., Trans. XIV. and XVI.) the moisture deposited by the SE. trade wind clouds on the vegetation growing on the summit of Table Mountain. In this part of Africa three-quarters of the rainfall occurs in the six winter months, 3 per cent. in the summer months, Dec. to Feb. On Table Mountain vegetation is much more abundant in the summer than on the slopes because clouds form on the top, and the plants stop the big drops, while the strong winds, blowing often at 40 miles an hour, carry the small drops away. Swamps are formed on Table Mountain which dry up in the dry season, during which no rain may fall for two months, but reappear with the SE. clouds. A mountain stream which can furnish 60 h.p. gave only 20 h.p. three days after a fire which had burned the bush and grass at the head of the stream. H. B.

584. *Blowing Springs of Georgia, U.S.* **S. W. McCallie.** (Science, 25. pp. 226–229, Feb. 8, 1907.)—The Grant Blowing Spring, near Chattanooga, the Boston Well, and Lester Well belong to two classes. In the first (Grant Spring) the air rushes inward for a time and reverses its flow after a short period of quiescence; the author believes that the outgoing current accompanies a rise of the barometer, and the ingoing current a falling barometer, and that the temperature inside and outside the cave, from which the spring flows, does not affect the air currents. In the wells and springs of the second class the air currents always move in the same direction with the same energy, independently of the rise and fall of the barometer, and the phenomenon is caused by the friction of the air on a rapidly moving stream of water. The well itself is, in the two cases discussed, the inlet for the air which must have an outlet elsewhere, and subterranean waterfalls probably produce the blast. H. B.

585. *Seiches in Lake Chiuzenji.* **K. Honda.** (Physico-Mathematical Soc., Tokyo, Proc. 3. 11. pp. 220–223, Jan., 1907.)—The picturesque lake, about 6 km. long and 2 km. wide, is situated near Nikko, at an altitude 1,316 m.; average depth 100 m., maximum depth 172 m. The author's portable limnometer is a zinc cylinder, suspended over a pulley by a wire

carrying a pen, which records on a drum with vertical axis; the pen-holder is guided by two V-shaped position wheels. The limnometer was taken to different spots, and the nodal line clearly determined. The period of the uninodal oscillation is 7·70 min. The formula gave only 6·72 min.; restricting the calculation, however, to the more regular half W. of the nodal line, 7·78 min. was deduced, and the value approximately confirmed by experiments with a model. H. B.

586. *Investigation of the Seiches of Loch Earn by the Scottish Lake Survey.* Part I. *Limnographic Instruments and Methods of Observation.* **G. Chrystal.** Part II. *Preliminary Limnographic Observations on Loch Earn.* **J. Murray.** (Roy. Soc. Edinburgh, Trans. 45. 14. pp. 361–396, 1906.)—Chrystal has improved Sarasin's limnograph with the aid of Plantamour's band transmission. The steel tape passes over two identical pulleys, and a small wagon is clamped to the horizontal part of the tape. The wagon has two wheels on the one side, the sides of the V-grooves of the wheels being slightly convex; these wheels run on an edged rail. The one wheel on the other side has a slightly convex rim and runs on a flat rail. There are no lateral guide wheels. The pen is carried by a split tube hinged on a horizontal axis, which is pivoted on two conical bearings. The float, a hollow zinc cylinder, weighs 2·27 kg. with its load, the counterpoise only 0·68 kg.; if there is no load, the wagon will not promptly respond to a slow fall of the water-level. A new instrument of this type was made by A. H. Baird, of Edinburgh. For the study of the minor denivellations a Richard statoscope has been used. It is a cylinder communicating with the air by a stopcock, and containing several aneroid capsules, which are open, not sealed. This statoscope serves both as a barograph or as a statolimnograph. In the latter case the stopcock is connected by a tube with a cylindrical vessel, resting on a board in the water with which it communicates through a tube passing through the board. The author also suggests two very simple self-recording limnographs of a very portable type, a lever instrument and a band instrument. Denivellations are caused by precipitation and evaporation, by persistent and by fluctuating winds, by the swell following persistent winds, and by seiches. In order to separate these components from the seiches, Endrös places the float in a well, in a sheltered position, near the lake, with which it communicates by a pipe, the access tube. The author discusses the influence of the length and width of this access tube which eliminates seiches of higher nodality and may introduce both lag and damping. He passes to the theory of the statolimnograph and to his method of residuation. As the seiches are rarely pure, the compound limnogram curve is slipped back a distance τ along the t axis, and thus a new curve, residual with respect to τ, is obtained, whose ordinates represent the sums of the two component ordinates and which contain the harmonic oscillations of the original. In Part II. James Murray gives further particulars of the instruments. Three limnographs were worked simultaneously, one near the uninode, the other near the binode, the third at the end of the lake. Near St. Fillans Chrystal's instrument was placed in deep water. In the other spots the water is shallow, and the float was put in a little well, 2 ft. deep, dug into the loch, an access tube, up to 1¾ in. diam. and 100 ft. in length, being carried into the deeper water. Sarasin-Plantamour instruments with wagons made by McKinstry, of Comrie, were used. Murray and A. Fraser further used index limnographs, consisting of float, line passing over a vertical pulley, a pointer attached to the pulley, a scale on which the movement of the pointer is read, a well (a milk-can) for the float, (a piece of wood 4 in. diam.), and a siphon connecting the well with the loch. The instrument is mounted on a photographic camera tripod, which is placed near the water's edge. Murray and Fraser have taken readings every half-minute, the former on one day for eight consecutive hours. Elaborate experiments were made to ascertain the suitable dimensions of the access tubes. [See also Abstract No. 256 (1906).] H. B.

587. *Seismological Notes. Valparaiso Seismograms.* **J. Milne.** (Nature, 75. pp. 402–403, Feb. 21, 1907.)—R. D. Oldham has pointed out the dual character of the Valparaiso seismograms. After the preliminary tremor there follow two maxima or shocks, at 1.5 and 1.50 G.M.T. on the Kew records; the second shock seems to correspond to the destruction of Valparaiso, at 7·59 local time; the first also came from some spot 105° distant, but nothing appears to have been felt at Valparaiso at 7.14. The International Seismological Association offers prizes for a new seismometer to record earthquakes of near origin; a magnification of 40 or 50 times is required, while in Japan magnifications of 6 or 10 have been found sufficient. In most instruments of the British Assoc. pattern the photographic paper moves at the rate of 60 mm. per hour, in a few at the rate of 250 mm. The two types give similar records, except that with earthquakes of feeble intensity the commencement of the preliminary tremor is sometimes lost on the slowly moving paper. H. B.

588. *Temperature of the Fresh-water Lochs of Scotland, with Special Reference to Loch Ness.* **E. M. Wedderburn.** (Roy. Soc. Edinburgh, Trans. 45. 16. pp. 407–489, 1907.)—The heating of a lake so much depends upon local conditions and the phenomena are so complicated that a comparative study of the fresh-water lochs of Scotland cannot yet be attempted. Observations in one part of a lake are not typical for the lake as a whole. There is no general relation between the mean temperature and mean depth, volume, elevation, and area of a lake; even the relation between temperature and volume/area, suggested by J. Murray and L. Pullar, is obscured by varying factors. The observations recorded in the 55 pages of tables in this paper were made by John Murray, L. Pullar, T. N. Johnston, R. C. Marshall, James Murray, E. R. Watson, F. G. Pearcey, the author, and the boatmen of the Scottish Lake Survey, from July, 1903, to Sept., 1904, and then continued by the Brothers of St. Benedict, particularly by C. v. Dieckhoff and O. Blundell, up to May, 1905. At the Lake Survey station at Fort Augustus deep-sea reversing thermometers were used, and cruises made on a launch. Then a yacht—the *Rhoda*—was fitted out for observations with a Callendar electrical recorder, comprising a cable of four insulated wires and platinum-resistance thermometers; numerous difficulties were experienced with this apparatus, which was largely used. A special immersion bolometer was also applied, and stations were erected along the loch for simultaneous observations. In the general discussion of the data, reference is made to the influence of rivers entering the loch, but not to springs in it; the loch never freezes except near the shore. The greatest quantity of heat is contained in the loch about Sept.; the lowest bottom temperatures of the water were observed in April, the highest in Nov. at a depth of 700 ft. The water cools off after Sept. in an entirely different manner from that in which it gained its heat. The surface cools in Aug., the lower strata—as a rule observations were taken to depths of 200 ft.—keep on getting warmer. These changes seem to be connected with the "Sprungschicht," indicating the lower border of a layer of uniform temperature, whose level and thickness vary, and below which the temperature falls abruptly. This Sprungschicht is due to the winds which shift the surface water bodily, and thereby cause a return current; the surface water is warm in summer, but cold in autumn, when the wind by its mixing action increases the thickness of the layer. Temperature seiches, first suggested by Watson in 1904, were distinctly observed, and they are connected with oscillations of the Sprungschicht. By Nov. the Sprungschicht has sunk so much that the seiches do not any longer affect depths of 200 ft. Floods little influence the temperature of the whole, because the flood water keeps much together. The bolometer did not prove of much utility, because the water is rarely at rest. In winter the water seemed sensitive to the sun-rays down to depths of 12 or 16 ft.; in Aug. the bolometer hardly marked any difference between day and night at 10 ft., and sunshine and cloud could not be distinguished at a depth of 2 ft. According to the Callendar recorder the surface temperature changed by 6° F. within 2 min. in one case, and the movements of pollen particles demonstrated an agitated condition of the apparently quite calm surface. H. B.

589. *Examination of the Lighter Constituents of Air.* **J. E. Coates.** (Roy. Soc., Proc. Ser. A. 78. pp. 479–482, Feb. 2, 1907. Chem. News, 95. pp. 16–17, Jan. 11, 1907. Zeitschr. Phys. Chem. 58. pp. 625–629, March 28, 1907. Translation.) — This investigation was undertaken with a view of ascertaining whether any constituent lighter than helium is present in air, and also to estimate the amount of free hydrogen present in the atmosphere. No evidence was found of the existence of any new constituent, as the spectrum of the light fractions showed no lines which could not be attributed to hydrogen, neon, or helium. For the second part of the investigation about 78,500 litres of air were liquefied and systematically fractionated, and it was found that ice of hydrogen was obtained from 3,550 litres of air. In a similar blank experiment with air, to which a known volume of hydrogen had been added, only about half the hydrogen was recovered. Using these results to correct the former, it is estimated that there is 1 c.cm. of hydrogen in 1,583,600 c.cm. of air. E. C. C. B.

590. *Simple Apparatus reproducing the Details of Foucault's Pendulum Experiment on the Earth's Rotation.* **G. Blum.** (Comptes Rendus, 144. pp. 364–366, Feb. 18, 1907.)—The apparatus consists of a sphere and a little pendulum which can be made to oscillate on the surface of the sphere in any latitude. The sphere, which revolves on a vertical axis, is 22 cm. diam., and has a slot 6 cm. wide cut along one semi-meridian. The stage carrying the pendulum slides in this slot, and can be clamped where desired. The pendulum, a thin wooden rod 6 cm. long with a wooden bob 6 mm. diam., is attached at the top to a thread, and at the bottom to a spiral spring which constrains it to oscillate in a plane always normal to the sphere. The bob swings in a round hole cut in the stage, and can be hooked to any desired point of the rim of this hole. When the globe is rotated, the hook is raised by means of a pin coming in contact with a fixed meridian arm attached to the base of the apparatus, and the pendulum is thus released. The rotation of the plane of oscillation relatively to that of the sphere is seen to be equal but of opposite sign if the pendulum be at either pole, and zero at the equator. In any other latitude the rotation of the plane is to the rotation of the globe in a ratio equal to the sine of the latitude. The angle of rotation of the plane of oscillation may be estimated by eye, and the law thus roughly verified. The sense of the deviation of course changes sign on passing from

one hemisphere to the other. The last fact may also be verified by means of a simpler but rougher arrangement, in which the sphere is dispensed with. The observer holds in his hands the frame supporting the pendulum, which in this case should be large, and whirls himself round. A. E.

591. *Accuracy of Astronomical Clocks.* **W. S. Eichelberger.** (Nature, 75. p. 358, Feb. 7, 1907. Address to Amer. Assoc. for Advancement of Science. Science, 25. pp. 441–452, March 22, 1907.)—The rates of the standard clocks at the chief national observatories are discussed, and an attempt is made to determine the value of the mean deviation of daily rate. The chief results are as follows:—

MEAN DEVIATION OF DAILY CLOCK RATE.

				Seconds.
Bradley's		Clock	1759	0·102
Greenwich Observatory		„	1850	0·149
Greenwich	„	„	1900	0.051
Berlin	„	„	1877	0·02–0·08
Leyden	„	„	1900	0·028
U.S. Naval	„	„	1904	0·015

C. P. B.

592. *Variations of Wave-lengths in the Solar Spectrum.* **J. Halm.** (Astronom. Nachr., No. 4146. Nature, 75. p. 304, Jan. 24, 1907. Abstract.)—The author discovered a previously unknown "shift" in two of the spectrum lines employed in the determination of the sun's rotation period during 1901–6. The variations appear to show a periodicity of about 3 years' duration. C. P. B.

593. *Researches on the Solar Atmosphere. Vapours giving Dark Lines and Clouds of Particles.* **H. Deslandres** and **L. d'Azambuja.** (Comptes Rendus, 144. pp. 229–236, Feb. 4, 1907.)—The spectrographic researches here described, which were carried on at Meudon in 1906, relate to portions of the sun's atmosphere as yet almost unknown. The apparatus employed comprises a polar siderostat with plane mirror, and an astronomical objective of 0·2 m. aperture and 3·1 m. focal length, not achromatised for the chemical rays. Two spectrographs of different dispersions are carried on a large metal table inclined at 49°, and movable perpendicular to the meridian. [See Bull. astronomique, Sept., 1905.] The immediate objects of investigation were very fine dark lines, such as the central dark line λ4045 of iron, and the central dark line K_3 of calcium, which give images differing from those previously obtained in these regions, and revealing more elevated layers. These extremely fine lines are difficult to isolate, and it was found necessary to use the grating spectrum of the 4th order, and to repeatedly increase the length of the camera. Considerable difficulty was experienced in obtaining a suitable second slit, the edges having to be thin, very true, and of curvature identical with that of the line under observation. The slit first tried had stepped edges of nickel. Afterwards excellent results were obtained with another species of slit, traced on a silver film chemically deposited on a plane-parallel glass plate, the film side being next the lens. The width is inadjustable, but this can be got over by tracing several parallel slits of graduated width on the same film. On the margin of each monochromatic photograph, two solar spectra are registered, by exposing through the ends of the slit, in order to test adjustments. In the case of the line λ4045,

when the shaded portions of the line are isolated the brilliant patches of faculæ appear clearly at the centre of the solar disc; but when the fine black central line is isolated they are invisible in the resulting image. Similar results were obtained for the iron line λ4885 and, though less definitely, for other narrower lines. The degraded portions only give the bright faculæ patches; the dark central line gives a different image; this image, small and sharp, shows a network of little inequalities which are peculiar to it, for they disappear on isolating a bright interval of the spectrum between two dark lines close by. Probably the image for the central line represents an upper layer of iron vapour. The line K_3 gave images which do not show all the bright patches in the K_2 image, but the differences are not so great as expected. Possibly the dispersion and excellence of slit were not sufficient. "In any case these images have no relation to Hale's dark calcium flocculi, which are seen with low dispersion." The clouds of particles on the exterior limb have also been examined, but only under low dispersion. The ordinary prominence line K_3 was first isolated, and then portions of K_1. On several occasions, and particularly on July 20, in lat. 20° N., an image for K_1 was obtained, differing from that for K_3, and probably due to particles, unless K_3 was displaced by radial velocity during the exposure on K_1. It is hoped to settle this last point by the help of new apparatus. (Ibid. p. 352, Feb. 11. *Erratum.*) A. E.

594. *Lane's Spherical Gaseous Nebula Problem.* **Kelvin.** (Nature, 75. pp. 368–369, Feb. 14, 1907.)—Lane's problem is the convective equilibrium of density, of pressure, and of temperature, in a rotationless spherical mass of gaseous fluid, hot in its central parts, and left to itself in waveless quiescent ether. For the full discussion of this it would be necessary to solve for all past and future time. For a first essay, however, Fourier's method may be adopted, considering the gaseous globe as being at any time given with any arbitrarily assumed distribution of temperature, subject only to the condition that it is uniform throughout every spherical surface concentric with the boundary. If the fluid globe were given with any arbitrary distribution of temperature, for example uniform temperature throughout, the cooling, and consequent augmentation of density of the fluid at its boundary, by radiation into space, would immediately give rise to an instability according to which some parts of the outermost portions of the globe would sink, and upward currents would consequently be developed in other portions. In any real fluid, gaseous or liquid, this automatic stirring would tend to go on until a condition of approximate equilibrium is reached, in which any portion of the fluid descending or ascending would, by the thermodynamic action involved in change of pressure, always take the temperature corresponding to its level—that is to say, its distance from the centre of the globe. The condition thus reached is not perfect equilibrium. Examples are given of gases of varying thermal capacities, which exhibit curves of density and temperature in convective equilbrium agreeing closely with the curves found by Homer Lane. C. P. B.

595. *The Theory of Gases and Globular Star-clusters.* **H. v. Zeipel.** (Comptes Rendus, 144. pp. 361–364, Feb. 18, 1907.)—The author, inspired by an idea of Kelvin's, seeks to apply the kinetic theory of gases to the distribution of stars in globular clusters. For a gas in a state of spherical equilibrium, under the action of no forces except the mutual attractions of the molecules, the density can be expressed as a certain function $\psi(x)$ of the distance x from the centre. If the molecules of a gas of density

$\psi(x)$, filling a sphere of radius X, are projected perpendicularly on a plane, we obtain a circular disc whose surface density at a distance x' from the centre is given by another function, $\phi(x', X)$, which can be calculated from ψ. The author, having first computed $\psi(x)$ for the values $x = 1, 2, 3 \ldots, 65$ by ordinary interpolation methods, then evaluated the function ϕ for the values $X = 5, 6, \ldots, 24, 25$ and $x' = 0, 1, 2 \ldots X$ by mechanical quadratures. On comparing the calculated results with observations of the clusters ω Centauri and Messier 3, the only ones for which the observed data are sufficient, he found that the distribution of the stars only agrees with the theory in the central portions of the clusters, the density in the marginal portions being less than the theory requires. The radius of the sphere within which the law holds is $R = 9'$ for ω Centauri, and $R = 3'$ for Messier 3. Assuming these values of R, he calculates the density function for various distances from the centre. Expressing velocities in km. per sec., and taking as unit of mass the sum of the masses of the sun and earth, the formula $mp = 0''\cdot005889\,N\overline{\nu^2}$ is deduced, m being the mass (supposed common) of each star, p the parallax of the cluster, N a constant for the cluster, and $\overline{\nu^2}$ the mean square of the velocities in the line of sight. For ω Centauri, $mp = 0''\cdot00040\,\overline{\nu^2}$; and for Messier 3, $mp = 0''\cdot00059\,\overline{\nu^2}$. Hence, by spectroscopic measures of $\overline{\nu^2}$, mp might be determined. A. E.

596. *Brightness of a Planet.* **C. T. Whitmell.** (Observatory, 30. pp. 96–100, Feb., 1907.)—Light reflected to the observer from an illuminated hemisphere is less than would be reflected from a flat circular disc with the same diameter. From a formula of Mascart's ("Traite d'Optique," tome iii.), based on Lambert's law, the author calculates a table giving for various phases the total brightness, and the projection perpendicular to the sight-line, of the visible area of a planet. The total brightness falls off more rapidly than the projected area, so that according to the table the light of half moon is about 3/10 that of full moon, and the maximum brilliancy of Venus does not occur when the projection of her visible illuminated area is at its maximum for the earth, contrary to the usual belief. Müller, however, makes it clear that Lambert's theory cannot be accepted, and that only by an empirical formula deduced from observation can agreement be attained. In the special maximum brilliancy case it is probably nearly correct to assume, with the Nautical Almanac, that the brightness varies as the projected visible area, and to take no account of the obliquity of the rays. The author points out an error in Badcock's formula for the brightness, overlooked in a previous communication [Ibid. 29. pp. 462–464]. A. E.

597. *Variable Radial Velocity of α Scorpii.* **W. H. Wright.** (Astrophys. Journ. 25. p. 58, Jan., 1907.)—Approximate measures of a number of spectroheliograms of Antares (*α* Scorpii), taken at the Lick Observatory, placed its radial velocity at —6 km. per sec. From photographs obtained by the D. O. Mills' expedition at Santiago during 1904–5, velocities varying from —2·3 to +1·2 km. were determined. Recent determinations made specially at Mount Hamilton fully confirm the variability. It is mentioned that Miss Maury finds indications of a secondary or faint superimposed spectrum in the case of Antares, but it is ascribed to the telescopic companion. C. P. B.

598. *Spectrum of o Ceti (Mira).* **V. M. Slipher.** (Astrophys. Journ. 25. pp. 66–67, Jan., 1907.)—Photographs of the spectrum of Mira were obtained

at the Lowell Observatory during the bright maximum in Dec., 1906, using vanadium, iron, and sodium for comparison. The hydrogen lines are bright, and appear to increase in intensity with decrease of wave-length. H_a is shown distinctly although faint, and the author considers this is the first observation of the line as bright in Mira or any of the long-period variables of its class. It is also stated that the vanadium absorption lines are very strong in Mira as compared with other metallic lines. C. P. B.

599. *Stars with very Rapid Light-variation.* **J. Baillaud.** (Comptes Rendus, 144. pp. 250–253, Feb. 4, 1907.)—On the photographs of the Astrographic Chart each star is shown as a set of three images, produced by the telescope being slightly moved after successive exposures of 30 min. During the examination of certain of these plates the author found that the relative magnitudes of some of the images were variable, and in one case the amount was as great as 1½ magnitudes in the interval of 90 min. Special precautions were taken to avoid spurious changes due to dust, &c., on the plate. C. P. B.

REFERENCES.

600. *Arrangement for Variable Damping of the Horizontal Pendulum.* **O. Hecker.** (Zeitschr. Instrumentenk. 27. pp. 6–7, Jan., 1907.)—The enlargement of earth tremors on the seismogram varies enormously with the period of the pendulum. A multicellular system of vanes is described which, when attached to the end of the pendulum, conduces to more uniform results. The attachment is capable of a certain amount of variation in adjustment. G. E. A.

601. *Summation of Stresses in Certain Structures.* **J. C. Trautwine, Jr.** (Eng. Club Phil., Proc. 24. pp. 123–145; Discussion, pp. 145–146, Jan., 1907.)—The author discusses the following cases of the effect of an external force upon a structure in which there are internal stresses: The structure consists of two members which initially maintain stresses in one another—in one tension, in the other compression; the external force upon the structure is either tension or compression in the same direction as each of the other forces; one of the members may or may not be capable of having the sign of its stress reversed. The method is applied to the design of stave pipes used for carrying water under moderate pressure. F. R.

602. *Bending of Curved Beams.* **C. Pfleiderer.** (Zeitschr. Vereines Deutsch. Ing. 51. pp. 209–213, Feb. 9, 1907.)—The author arrives at formulæ for the bending of beams of uniform section, whose axis is curved, introducing a term for lateral expansion or contraction. They are applied to some of Bach's experimental results, and curves showing distribution of stress in a section are given. F. R.

603. *Web Stresses in Plate Girders.* **W. E. Lilly.** (Engineering, 83. pp. 136–139, Feb. 1, 1907.)—An experimental study of the effect of various dispositions of stiffeners on the deformation of the web of a plate girder.

604. *Specific Gravity of Portland Cement.* **D. B. Butler.** (Inst. Civil Engin., Proc. 166. pp. 342–345, 1905–1906. Abstract.)—The author's experiments show that the specific gravity of Portland cement is not an indication of proper calcination, being dependent on the time and opportunity it has had for absorbing water and CO_2 from the atmosphere. The sp. gr. may, however, be of occasional corroborative value in determining slag or other adulteration. F. R.

605. *Dependence of Gravity on Temperature.* **L. Southerns.** (Roy. Soc., Proc. Ser. A. 78. pp. 392–403, Dec. 20, 1906.)—In the account of the author's experiments given in Abstract No. 187 (1907) the first part of line 9 should read as follows: "the temperature of the oil being raised only 4 or 5 degrees in the preliminary experiments; the maximum rise obtained was about 32 degrees." EDITOR.

606. *Definition of Solid and Fluid.* **A. C. Lane.** (Science, 25. pp. 190–191, Feb. 1, 1907.)—Criticises the use of the terms "solid" and "fluid" in articles by Willcox and others (Ibid. Nov. 9, 1906). According to Willcox any substance would be a fluid when stressed until its plastic yielding commences; the author on the contrary recognises this condition as that of a plastic solid, unless it be reached at zero pressure. A fluid he defines as having a temperature such that its plastic yield-point is reached even at zero pressure. It may be that neither definition is absolutely rigorous, *i.e.*, that every fluid can rest under a minute amount of strain and that every solid has some plasticity. F. R.

607. *Initiation of Deep-sea Waves.* **Kelvin.** (Roy. Soc. Edinburgh, Proc. 26. pp. 399–436, 1905–1906. Phil. Mag. 13. pp. 1–36, Jan., 1907.)—This continues the analysis given in preceding papers [see Abstracts Nos. 1180 (1905) and 498 (1906)]. Three classes of waves are considered—those arising (1) from a single displacement, (2) from a group of equal and similar displacements, (3) from a periodically varying surface pressure. The treatment is entirely mathematical. J. W. P.

608. *Stationary Waves in Running Water.* **V. W. Ekman.** (Ark. för Mat. Astron. och Fysik, Stockholm, 3. 2. pp. 1–30, 1906.)—Kelvin's treatment of the stationary waves set up in a channel of rectangular section by a low smooth ridge stretching right across the bottom is here extended to the corresponding three-dimensional problem, particular attention being paid to the case of the waves being generated by a single body at the bottom of the stream and of dimensions which are small in comparison with the length of the waves considered. A. W.

609. *Explosive Wave.* **Jouguet.** (Comptes Rendus, 144. pp. 415–417, Feb. 25, 1907.)—The postulate, that for a wave of shock to be propagated its speed must not be less than that of sound in the medium preceding it nor greater than that of sound in the medium following it, is here applied to the circumstances of an explosive wave. R. E. B.

610. *Drops and Capillarity.* **T. Lohnstein.** (Ann. d. Physik, 21. 5. pp. 1030–1048, Dec. 14, 1906, and 22. 4. pp. 767–781, April 4, 1907.)—A full reply to F. Kohlrausch's criticism [Abstract No. 1667 (1906)] and an amplification of the theory of the original paper (*ibidem*). A. D.

611. *Remarkable Lunar Halo.* **H. F. Hunt.** (Nature, 75. p. 439, March 7, 1907.)—Description of a lunar halo observed at Pembroke Dock during the evening of Sunday, Feb. 24, between 9 p.m. and 10 p.m. The secondary ring appeared to be about as large again in diam. as the primary, and was situated approximately to the north-east of it. In both rings the brownish tinge of the edges and dark interiors were perceptible, though very much more strongly in the primary than the secondary. C. P. B.

612. *Spectroscopic Binary o Leonis.* **W. Zurhellen.** (Astronom. Nachr., No. 4151. Nature, 75. p. 378, Feb. 14, 1907. Abstract.)—From twelve plates taken with the spectrograph of the Bonn Observatory during April, 1905, and April, 1906, the semi-axis of the relative path of the two components is found to be 0·15884 of the sun's distance, while the masses of the components relative to the sun's mass are 1·858 and 1·185 respectively. C. P. B.

613. *Russian Observations of the Solar Eclipse, Aug. 30, 1905.* **C. P. Butler.** (Nature, 75. pp. 163–164, Dec. 13, 1906.)—A brief *résumé* of the results obtained at Alcocebre by the expedition from the Pulkowa Observatory, taken from the official publication.

614. *On a Possible Reversal of Deep-sea Circulation.* **T. C. Chamberlin.** (Amer. Phil. Soc., Philadelphia, Proc. 45. pp. 33–43, Jan.–April, 1906.)—The influence of geologic climates is considered.

615. *Mutual Occultations and Eclipses of the Satellites of Jupiter.* **J. A. C. Oudemans.** (Konink. Akad. Wetensch. Amsterdam, Versl. 15. pp. 179–210, Oct. 10, and pp. 439–453, Dec. 5, 1906. Proc., 9. pp. 304–335, Nov. 22, and pp. 444–458, Dec. 21, 1906.)—Details of the computation of times when the satellites of Jupiter will be in favourable position for mutual occultation or eclipse as seen from certain places on the earth. C. P. B.

616. *Red Spot on Jupiter*, 1905–6. **S. Williams.** (Astronom. Nachr., No. 4150. Nature, 75. p. 327, Jan. 31, 1907. Abstract.)—The transit times of the observations during 1905–6 were all simple eye estimates, care being taken to avoid looking at the red spot hollow, which was a conspicuous feature. The rotation period derived from 635 rotations was found to be 9h. 55m. 41·46s., which is slightly less than the value determined from the 1904–5 observations. C. P. B.

617. *Peculiar Short-period Variable.* **Müller** and **Kempf.** (Astronom. Nachr., No. 4148. Nature, 75. p. 327, Jan. 31, 1907. Abstract.)—The sixth magnitude star B.D. +68°·200, in Cassiopeiæ, is found to be a variable having a period of 1·95 days and a remarkable small range of light-variation, the whole amounting to only 0·33 magnitude. The observations were made at Potsdam during 1906. C. P. B.

618. *Mass of Biela's Comet.* **J. v. Hepperger.** (Akad. Wiss. Wien, Sitz. Ber. 115. 2a. pp. 785–840, June, 1906.)—From discussion of the perturbations, the ratio of the mass of Biela's comet to that of the earth is found to be approximately 1 : 2,400,000, this value being more probably too large than too small. Some remarks are added on the relation between the brightness and mass of comets in general, and an attempt is made to derive information regarding the masses of other comets from that of Biela's by means of the formula $\log m'/m = 0{\cdot}4\,(\mathrm{H} - \mathrm{H}')$, where m stands for mass, and H for magnitude reduced to unit distance. A. E.

619. *Proper Motion of Castor.* **A. C. D. Crommelin.** (Royal Astronom. Soc., Monthly Notices, pp. 140–143, Dec., 1906. Nature, 75. p. 304, Jan. 24, 1907. Abstract.)—By considering both the true proper motion and the orbital motion of the system of α Geminorum (Castor) the author has determined a new value of the proper motion of the centre of gravity of the system, this being $-0{\cdot}0135$ sec. $+0''{\cdot}120$ sec. C. P. B.

620. *Orbit of Spectroscopic Binary λ Andromedæ.* **K. Burns.** (Astrophys. Journ. 24. pp. 345–350, Dec., 1906.)

LIGHT.

621. *Vertical Coelostat Telescope.* **G. E. Hale.** (Astrophys. Journ. 25. pp. 68–74, Jan., 1907. Contribution from the Solar Observatory, No. 14.)—Many difficulties have arisen at the Solar Observatory owing to the disturbing effects of the sun's heat on the definition of the image, and after various plans have been tried it has been decided to build an instrument on an entirely new plan. Two entirely independent galvanised steel towers about 60 ft. high will be provided, one to support the coelostat, the other to protect the inner tower from the wind. A second mirror will receive the solar beam from the coelostat mirror of 17 in. diam., and both glasses will be 12 in. thick in order to reduce the effects of thermal distortion. They will be silvered on both sides and exposed to the sunlight on as much of their surfaces as possible. From the secondary mirror the light will be reflected vertically downward to a 12-in. object-glass by Brashear, having a focal length of 60 ft., which gives an image of the sun on the slit of the spectroheliograph. The spectroheliograph will have objectives of 30 ft. focal length. To obtain the necessary translation of the solar image the object-glass will be moved by an electric motor, which also drives the photographic plate across the camera slits. Three secondary slits are to be used, so that three photographs of the same part of the sun may be taken simultaneously with the aid of different spectral lines. Provision is also to be made for the photography of sun-spot spectra with a Littrow spectrograph of 6 in. aperture and 30 ft. focal length, combined with a plane grating. C. P. B.

622. *Spectroheliograph Slit Arrangement.* **G. Millochau.** (Comptes Rendus, 144. pp. 360–361, Feb. 18, 1907.)—Some further remarks are added respecting a device described in a former note [Abstracts Nos. 876 (1906) and 598 (1907)]. The second slit is enlarged for a short portion of its length at either end, to form openings through which a portion of the solar spectrum can be observed or photographed before and after each exposure with the spectroheliograph. These openings can be closed at will. The device is intended to serve the following uses: (1) Facile adjustment to parallelism of the second slit and the spectrum lines. (2) Adjustment of position of the second slit relative to the spectrum. (3) To find whether any disturbance of the spectroheliograph has occurred during an exposure. (4) To measure the exact radiation which has produced the monochromatic photograph. Štefánik has shown that, by the use of coloured screens before the slit, the limits of vision can be extended to include from $\lambda = 0{\cdot}9\,\mu$ to $\lambda = 0{\cdot}387\,\mu$ [see Abstract No. 1875 (1906)]. Hence the above device can also be employed for visual regulation within those limits. A. E.

623. *Optical Intensification of Paintings.* **R. W. Wood.** (Scientific American, 96. p. 134, Feb. 9, 1907.)—The narrow range of luminosity obtainable on canvas is increased by the following means: A photograph of the painting is taken on an orthochromatic plate, a lantern slide made from the negative, and this picture is projected on the original painting. G. E. A.

624. *Measurable Weakening of Light by Rotating Prisms and Fixed Sector.* **E. Brodhun.** (Zeitschr. Instrumentenk. 27. pp. 8–18, Jan., 1907. Communication from the Physikal.-Techn. Reichsanstalt.)—The rotating prisms are two in number, and their sections, parallel to the axis of rotation, parallelograms with angles of 45°. The prisms are placed so that a ray of light entering the end of one is reflected twice at right angles within each prism, resuming its original course on emerging from the end of the second prism. The fixed sector lies between the two prisms. Any ray parallel to the axis of rotation describes, after passing through one prism, a circle on the plane of the sector. The more general case is considered of a ray which is not parallel to the axis of rotation of two mirrors, and the general result is deduced that if the mirrors rotate with constant velocity all rays incident on the first mirror describe equal circles with constant velocity on the plane of the sector. This result is not altered by the use of total reflecting prisms. The instrument, as constructed by Schmidt and Haensch, is illustrated and described, the prisms being rotated by a small motor. The apparatus when complete can be used as a portable photometer for measuring, for instance, the percentage of light passing through an absorbing medium, or the reflecting power of a given surface, the result being in each case read off on a circular scale. G. E. A.

625. *Absorption and Magneto-optical Properties of Crystals at Liquid-air Temperatures.* **J. Becquerel.** (Comptes Rendus, 144. pp. 420–422, Feb. 25, 1907.)—It is known that crystals of xenotime and tysonite possess absorption bands, which vary under the influence of a magnetic field. These crystals contain magnetic substances (erbium, &c.), and it seemed to the author important to find if the magnitude and sense of the displacement of the bands was connected with the magnetic properties of those substances. Paramagnetism being a function of the temperature, while diamagnetism is, in general, independent, it was natural to seek, first of all, whether the changes of period of the electrons, in the bodies placed in the magnetic field, depended on the temperature. This has now been carried out, and with the following result: At the temperature of liquid air the optical properties of these crystals approach those of transparent vapours possessing a spectrum of rays. The interpretation of this result, in the theory previously developed, is that the *period* of the motion proper to the electrons is *not* influenced by the temperature in the solid body, but that the *damping*, that is, the resistance experienced by the corpuscles in vibration, *increases and diminishes with* the temperature. [See also Abstracts Nos. 236 and 266 (1907).] E. H. B.

626. *Colour Diagram for Interference and Polarisation Phenomena.* **C. Barus.** (Science, 25. pp. 348–350, March 1, 1907.)—The colour effect to be obtained from a given thickness of quartz is expressed by means of a diagram. The mathematical expression for the rotation of any ray in terms of the thickness of the quartz is graphed, taking rotation as ordinate and thickness as abscissa. Each colour is thus represented by an oblique line from the origin, and the colours to be anticipated for a given thickness are found by drawing the proper ordinate, the reading of the chart being aided by the presence of dark horizontal lines for values of rotation which give even multiples of $\pi/2$, and dotted horizontals for odd multiples. It is also explained how the chart may be modified to exhibit the effect of thin plates in polarised light, and the effects of interference and diffraction. G. E. A.

627. *Plane Reflection Diffraction-gratings for Wave-length of Light.* **E. Giesing.** (Ann. d. Physik, 22. 2. pp. 333–364, Feb. 5, 1907. Extract from Dissertation, Tübingen.)—This paper deals very fully with the degree of accuracy attainable with a plane reflection grating applied to the absolute determination of wave-lengths of light. As source a mercury lamp was used and photographs were taken on films. The grating constants at 17° C. were $25{\cdot}3447_9\,\mu$ and $25{\cdot}3446_5\,\mu$ each $\pm 0{\cdot}0002\,\mu$ and their expansion-coefficient $(18{\cdot}26 \pm 0{\cdot}10)\,\mu$ per 1° C. per metre. The results finally obtained are in good agreement with those of Perot and Fabry. [See Abstract No. 1265 (1900).]

E. H. B.

628. *Application of the Ultramicroscope.* **L. Michaelis.** (Zeitschr. Angew. Chemie, 19. pp. 948–953, 1906.)—With the ultramicroscope the limiting size of visible objects is $4\,\mu\mu$. The instrument has been used for examining solutions of various kinds, and it is found that dye-stuffs may be divided into classes according to the optical behaviour of their solutions. Some dye-stuffs behave exactly like colloidal gold solution, whilst fluorescent dye-stuffs give solutions in which no distinct particles are visible. Many dye-stuffs occupy an intermediate position between these two groups; in the case of thionine (Lauth's violet) the salts of the dye-stuff dissolve to a true solution, whereas the solution of the colour base itself in water is a suspension of ultramicroscopic particles. G. E. A.

629. *Ionisation and Anomalous Dispersion.* **G. A. Schott.** (Nature, 75. p. 461, March 14, 1907.)—The author replies to a criticism of Wood (Ibid. pp. 390–391, Feb. 21), that in his experiments on ionisation and anomalous dispersion [see Abstract No. 405 (1907)] the effects were probably due to disturbance of the density gradient of the sodium vapour, due to "local heating of the wire." It is now pointed out that the wire was a mere electrode, and carried a current of the order of 1 micro-amp. Further, in continuing the experiments, Needham found that while the tube was heated by a flame, with 10 volts there was a current of 4 divisions and anomalous dispersion of 9 divisions; and on raising the voltage to 58 the current rose to 10, but the anomalous dispersion fell to zero, and thereafter slowly increased to a greater value than before. The author explains this by saying that the increase of current corresponds to a sweeping of the systems producing the anomalous dispersion, towards the electrode.

S. G. S.

630. *Luminous Equivalent of Radiation.* **P. G. Nutting.** (Phys. Rev. 24. pp. 202–213, Feb., 1907.)—An attempt is made to measure luminous radiation in a scientific manner. The functions are not obtained analytically from physiological data. In many cases they are obtained by the method of trial and error, and are in excellent accord with experiments. The impression on the retina produced by radiation depends on the nature and the intensity of the radiation as well as the time during which it has acted. In addition, there are various subjective conditions. To make a purely physical definition of visual brightness possible we must, therefore, find the requisite functions of the energy, the wave-length, the time, &c. The same amount of power in beams of different wave-lengths produces different effects on the eye. The *visibility* of a beam, therefore, may be expressed by some function $V(\lambda)$ of the wave-length λ. For any arbitrary distribution $E(\lambda)$ of rays of different wave-lengths in a beam, the product $V(\lambda) \times E(\lambda)$ gives a third function $L(\lambda)$ which is called the luminosity or optical intensity of the beam. Again, the sensibility of the eye varies with the intensity of the incident light. With increase of intensity the sensibility decreases according to some function S(L) of the luminosity. This sensibility function may be found from data on the photometric constant, and includes Fechner's law as a special case. The results may be summarised as follows: (1) Radiation E(λ) may be translated into luminosity L(λ) by means of the relation $L = EV$, where V(λ) is the visibility function given by $V = V_1 \epsilon^{-a(\lambda - \lambda_m)^2}$, where V_1 is arbitrary. For low intensities $a = 4$ and $\lambda_m = 0{\cdot}51\ \mu$. a decreases and λ_m increases steadily as the intensity increases. (2) The least perceptible percentage difference in luminosity to which the eye is susceptible is closely represented by the function P(L), where $P(L) = P_m + (1 - P_m)(L_0/L)^c$, where $P_m = 0{\cdot}016$, $c = 0{\cdot}26$ approx., and L_0 is the dawning (threshold) value of the luminosity. P_m and c are nearly, if not quite, independent of the individual and of the colour. (3) Fechner's law $dL/L =$ constant, holding for moderate and high intensities, can be generalised so as to include low intensities as well, by writing it in the form $dL/L = P_m + (1 - P_m)/(L/L_0)^c$. (4) Visual brightness B or apparent luminosity may be represented by a function of the form $B = B_0 \log[1 + P_m(L^c L_0^{-c} - 1)]$. [Incorrectly given in original. Here as corrected by author.] A. R.

631. *Photography: Critical Exposures.* **P. Préobrajensky.** (Soc. Imp. Nat. Moscow, Bull. 1 and 2. pp. 161–179, 1906.)—If a plate be developed to the full, so that no prolongation of the development produces any further effect, the amount of exposure required to produce a maximum density depends on the nature of the plate alone; this is the "first critical exposure." For Ilford platino-bromide paper it is 2·8 cm. magnesium ribbon (0·75 gm. per metre) burned at 30 cm.; for Lumière plates (blue label) it is 1 cm. Exposures beyond this result in a fall-off in the density obtained. At a particular further value (the "second critical exposure") the action is completely reversed, and the result is clear glass; 800 cm. magnesium ribbon at 30 cm. for Ilford platino-bromide paper, and 8,000 cm. for Lumière plates (blue label). This enables negatives to be made direct from negatives, by daylight, on the basis that one second exposure to open blue sky is equivalent to 8–16 cm. magnesium ribbon at 30 cm. But in that case, if O, the range of opacities in the negative, be greater than E, the ratio between the second and the first critical exposure, the points of maximum density in the negative will be under-exposed, and the maximum density in the resultant will correspond to some point of intermediate density in the original negative. What has, then, to be done is to give the paper or plate a preliminary exposure equal to the first critical exposure × (E − O)/E, and then to give it, under the negative, an exposure a little less than the second critical exposure: by which means the two ends of the scale are given the first and the second critical exposures respectively. The intermediate gradation is correct if bromided stale developer, weak in iron or in alkali respectively, be employed. Such developers tend to reduce the density-curve to a straight ascent to the first critical exposure, and a straight descent to the second. A. D.

632. *Photographic Processes.* **S. E. Sheppard** and **C. E. K. Mees.** (Roy. Soc., Proc. Ser. A. 78. pp. 461–472, Feb. 2, 1907.)—The photographic process, in brief, consists in the passage of ionised silver to the metallic state, with a suboxidation stage probably intermediate. "Ripening" seems due (*a*) to formation of resonating systems or clumps of halides, and (*b*) to the formation of intermediate reduction-product; and the function of the gelatine is to assist in both of these. On exposure, light is absorbed and electrons are set free which ionise the haloid and the surrounding gas (*e.g.*, air); the gelatine having a high dielectric constant conserves the electrons, and the gas, according as it removes electrons or not, may reduce sensitiveness; electrons may be emitted either from the halide or from the sensitisers used. The gelatine combines with free halogen, and the ionisation of the halide leads to chemical reduction (electrolytically dissociated halide becoming discharged by interaction with electrons and positive atom or molions), probably forming a half halide Ag_2X in solid solution with halide, this being the latent image. The action is reversible, a definite halogen pressure corresponding to each intensity of light. The deviations from the law $t \propto I^{-1}$, where t is the time required to produce a given effect and I the corresponding intensity of light, are such that for $I = 84{\cdot}5$, $It = 17{\cdot}2$, and the curve descends to $It = 15{\cdot}5$ for I from about 6·00 to 0·18, then to rise to 86·2 for $I = 0{\cdot}0056$. The failure is not a steady function of t, is independent of the total value of It, and is relatively independent of the sensitiveness of the plate, *i.e.*, it starts at the same point relatively to the inertia point. The latent image may be destroyed (*a*) by free halogen during and after exposure; (*b*) by desensitisers (Cu'', Hg'', Fe''', and $(UO_2)''$ salts) acting during exposure by reversal of the photochemical action, there being in this case a catalytic action of an extremely small quantity of the desensitising kathion in solid solution or in some combination with the silver salt, this action being cyclic and involving the absorption of oxygen; (*c*) by oxidisers after exposure (possibly halogen released from gelatine); and (*d*) in "reversal," halogen reconverts the subhalide, and halogen absorbed in the gelatine reduces the developer. In development, the previous treatment accelerates reduction by a reducing agent. In the "induction period" silver germs are formed (gold, platinum, silver sulphide, gas ions from flame gases will act like silver germs) at a rate which chiefly depends on chemical processes; after which comes a deposition of silver on the germ, at a rate which depends on diffusion processes. The gelatine acts as a filter against germs, thus preventing fogging. Fixing removes the remaining halide. [See also Abstract No. 1724 (1905).] A. D.

633. *Action of Substances on the Latent Image.* **S. E. Sheppard** and **C. E. K. Mees.** (Photographic Journ. 47. pp. 65–93; Discussion, pp. 93–95, Feb., 1907.)—The experiments of J. Sterry on the effect of bathing plates in chromic acid are extended. Chromic acid, if allowed to act for a short time on an exposed plate, affects the lower exposures most, so that if a very strong solution be used for a very short time the whole of the front of the image will be wiped out, but at the back a very strong image will be found. A plate, however, which has been soaked in dilute chromic acid for a long time does not give abnormal curves. The action of the chromic acid is considered to be a purely physical one, this view being strengthened by the fact that sodium sulphite removes the effect of CrO_3 on the velocity constant [see Abstract No. 1724 (1905)]. The second part of the paper treats of the action of desensitisers such as uranium nitrate, it having been found that a plate soaked in a solution of this salt loses the greater part of its sensitiveness. Other salts of uranium have the same effect, and also cupric, ferric, and mercuric salts. A Gem process plate was made 64 times slower by soaking for a minute in a N/10 solution of $CuSO_4$. The view is taken that the action of the desensitiser occurs during exposure by reversal of the photochemical action, and not by any modification of the sensitive salt. The desensitising action is noticeable with extremely small quantities of the salts which possess the property. This may give a clue to some of the peculiar troubles occasionally met with in emulsion-making. In the *discussion*, **Sterry** said that upon most points he was quite in agreement with the authors, but he did not think that the reasons given fully accounted for the abnormal results he had described. G. E. A.

634. *Photography: Latent Image.* **E. Demole.** (Comptes Rendus, 144. pp. 565–567, March 11, 1907.)—Expose a plate under a negative; immerse it for some minutes in a 1 per cent. solution of potassium ferricyanide; rinse; develop in hydrokinone developer: great over-exposure is then found to have no effect at all in accelerating the development or as regards the result; and, further, if the development be carried out under the white light of a candle instead of the red lamp, a negative is obtained instead of a positive. The latter result is obtained even after a short exposure, but a prolonged exposure makes the product more vigorous. A Lumière plate (blue label) was sufficiently exposed for ordinary development by a 1-sec. exposure under a negative to an arc lamp at 50 cm. distance; with ferricyanide and under candle-light as above, exposures from 1 to 170 sec. gave negatives; but with 180 sec., the plate showed a positive which became a negative; with 7 min. a positive only, but not clear in the whites; with 14 min. a perfect positive. There is apparently a reaction $4Ag_2Br + 4H_2O - 3O_2 = 4(Ag - O - Br) + 4AgOH + 2H_2O$; the oxybromide is comparatively difficult to reduce by the developer alone, but with the aid of the white light it becomes more reducible, but less so than the surrounding AgBr, which has not been affected by the oxidation. A. D.

635. *Limits of Useful Work in the Fixing Bath.* **A.** and **L. Lumière** and **Seyewetz.** (Photographic Journ. 47. pp. 129–132, Feb., 1907. Translation.)—A number of practical conclusions are given as to the number of plates of a given size which can be fixed in a given quantity of hypo, *e.g.*, not more than 100 plates, 9 × 12 cm., in 1 litre of a 15 per cent. solution of sodium hyposulphite. As a practical test for the exhaustion of the fixing bath, a drop of it may be placed on a piece of paper which should then be exposed to light and warm air, noting whether the spot turns brown or not. G. E. A.

636. *Exception to a Theorem in Optics.* **J. R. Milne.** (Roy. Soc. Edinburgh, Proc. 26. pp. 527–528, 1905–1906. Abstract.)—An exception to the law, that "the intrinsic luminosity of the image formed by any lens system whatever is the same as the intrinsic luminosity of the object," exists in the case of polarised light, based on the fact that by the agency of a double-image prism two light rays polarised in directions mutually perpendicular may be combined into one ray which carries the total energy of both. In this way an intrinsic luminosity of image is attained which is twice that of the object. The foregoing principle is applied to the polarimeter to obtain greater illumination and the consequent increase in accuracy of adjustment. G. E. A.

637. *Spectrum of Radium from Radium Bromide.* **F. Giesel.** (Ber. Deut. Chem. Gesell. 39. p. 2244, 1906.)—The tube containing radium emanation, first examined twelve months previously [Abstract No. 1884 (1905)], now shows

all the helium lines as distinctly as in a helium tube, as well as hydrogen lines. Photographs of the spectrum of this tube, taken with the spectra of helium and of hydrogen tubes on the same plate, make the resemblances easily manifest. Thirteen of the helium lines could be readily identified in the spectrum of the radium emanation tube, viz., λ5876, 5048, 5015, 4922, 4718, 4472, 4388, 4144, 4121, 4026, 3965, 3889, 3819. The lines 7065 and 688(0?) in the red are also now visible. The exposure given was 20–40 min. L. H. W.

638. *Influence of Electrical Field on Spectral Lines.* **G. F. Hull.** (Astrophys. Journ. 25. pp. 1–22, Jan., 1907.)—The theoretical deductions regarding the electrical analogue of the Zeeman-effect do not lead us to expect that such an effect can be observed. When, however, the velocity of translation of a source through the ether approaches that shown by the canal rays of hydrogen (5×10^5 m. per sec.), we might get a wave-length change of the order of 0·015 tenth-metre—a quantity which may readily be observed. Experiments were made at various points along a discharge tube 3 or 4 cm. diam., so that the electrical field varied from zero behind the electrodes to its highest value (about 500 volts/cm.) near the kathode. The hydrogen lines H_β, H_γ, H_δ, were broadened, but not shifted in any case more than 0·1 tenth-metre. The lines of the second hydrogen series were not broadened, but appeared to be shifted in the kathode layer and in the canal rays by 0·01 tenth-metre towards the blue. C. P. B.

639. *Temperature Emission of Iodine Vapour.* **C. Fredenhagen.** (Phys. Zeitschr. 8. pp. 89–91, Feb. 1, 1907. Theoret.-phys. Inst., Leipzig, Dec. 15, 1906.)—Experiments with iodine are undertaken to decide whether the presence of temperature-differences in the radiating mass of gas leaves the spectrum unaltered or contributes to cause the appearance of bands. The following generalisations are made from the experiments: (1) The only system capable of selective emission is one which is not in equilibrium (*e.g.*, iodine vapour of non-homogeneous degree of dissociation). (2) A system in equilibrium can only give out continuous radiation (*e.g.*, iodine vapour of homogeneous temperature). (3) Selective absorption is always accompanied by a disturbance of equilibrium (*e.g.*, by dissociation of iodine molecules with the selective absorption of iodine vapour). (4) Continuous absorption does not correspond to a disturbance of equilibrium, but only to a rise of temperature in the absorbing system. [See also Abstracts Nos. 980 (1905), 1878 and 2032 (1906).] G. E. A.

640. *Discussion upon the Doppler-effect with Canal Rays.* **J. Stark.** (Phys. Zeitschr. 8. pp. 79–81, Feb. 1, 1907. Écl. Électr. 50. pp. 348–350, March 9, 1907.)—The difficulty of obtaining the Doppler-effect in the kathode glow has been dwelt upon by several authors; B. Strasser and M. Wien [Abstract No. 2036 (1906)], and F. Paschen [Abstract No. 58 (1907)]. In the present paper it is pointed out that the difference in the production of the Doppler-effect by the gas in front of and behind the kathode is to be expected for two reasons, the first being that the distribution of velocity of the positive "remainder" ions is very different on the two sides of the kathode, and the second that the layer of gas in which the emission which exhibits the Doppler-effect takes place is much greater in the case of the canal rays than in that of the gas in front of the kathode. A sketch of the mechanism by which the ions convert the energy of translation into radiation is given. The author imagines it to be due to the change of configuration of the paths of the electrons within the atom when the velocity through the ether is great. Every change of configuration is accompanied by an absorption of energy, the source of which is the kinetic energy of the atom. Energy is also absorbed when the path is changed by approaching a molecule of the gas, owing to change of configuration, but this is not retained as the atom recedes. It becomes energy of radiation, and is a maximum when the two remain together. Further, the amount of deflection of the path of an atom is less the greater the velocity, and hence the fact that in the canal rays the straight path of the atoms is much greater than their mean free path under normal conditions of temperature. This agrees with the fact that the viscosity of a gas increases with the temperature, the more slowly the higher the temperature; which was explained by W. Sutherland by considering that the molecular forces cause less deviation the higher the velocity of the molecule, the mean free path being thus increased. [See Abstract No. 1697 (1904).]

S. G. S.

641. *Elements causing Fluorescence in Minerals: Chlorophane, a Variety of Fluorspar.* **G. Urbain.** (Comptes Rendus, 143. pp. 825–827, Nov. 26, 1906.) —When the oxide obtained from chlorophane is diluted with lime, the kathode spectrum shows the absorption bands of samarium, terbium, dysprosium, and gadolinium; and when the phosphorescent fluorides prepared synthetically from pure lime and the pure oxides of the above metals are examined in the kathode tube, the phosphorescent bands observed coincide with those given by the chlorophane. [See also Abstracts Nos. 523, 1380, and 1568 (1906).]

T. H. P.

642. *Ultra-violet Phosphorescence Spectrum of Fluorspars. Variations of the Phosphorescence Spectrum of an Element in a Constant Diluent.* **G. Urbain** and **C. Scal.** (Comptes Rendus, 144. pp. 30–32, Jan. 7, 1907.)—In continuation of the investigations on chlorophane [see preceding Abstract], the authors examine the phosphorescence spectra of fifteen different fluorspars, in all of which gadolinium is shown to be present by its characteristic kathodic bands. The intensity of the bands varies greatly, however, with the concentration of gadolinium in the mineral, as is shown also by investigations with synthetic fluorspars. Hence an element may possess several phosphoresence spectra, in the same way as it may exhibit different flame, arc, and spark spectra.

T. H. P.

643. *Transparency to Röntgen Rays and Atomic Weight of Nickel.* **C. G. Barkla.** (Nature, 75. p. 368, Feb. 14, 1907.)—Benoist has shown the connection between the transparency to Röntgen rays of elementary substances and the atomic weight of those substances by means of a curve, which in general exhibits a fall of transparency with a rise in the atomic weight of the substance [see Abstract No. 1274 (1901)]. The author, in conjunction with C. A. Sadler, has found that by replacing Benoist's primary beam by secondary beams from different substances, curves are obtained similar to those obtained by using a beam direct from a Röntgen-ray tube, except in the region of atomic weights near to that of the radiator. In these regions a strongly marked deviation occurs, showing a special transparency to the secondary radiation from a substance, by a sheet of the same substance, and a less strongly marked abnormal transparency of those substances with atomic weights differing little from that of the radiator. Also the nearer on the same side the atomic weight of the absorbing substance is to that of the radiator, the greater is the deviation from the normal transparency. This effect does not indicate that the secondary rays as emitted by the atoms of a substance are specially penetrating, but simply that in emerging from the interior atoms to the surface a selective absorption has occurred, leaving the remainder specially penetrating to further layers of the same substance and to a less extent to substances of neighbouring atomic weights. This is not a property of secondary rays alone, for experiments on primary beams which have passed through thin sheets of metal show the same effect. In making such experiments it was found that the radiation from nickel was much more abnormally penetrating to copper than to iron, indicating a proximity of atomic weight to that of copper. On the other hand, when cobalt was used as a radiator the rays were much more abnormally penetrating to iron than to copper, indicating that the atomic weight of cobalt is nearer to that of iron than of copper. The two experiments seem to show that the atomic weight of nickel is not slightly less than that of cobalt, but considerably greater. Using a thin plate of aluminium as the absorber, the relation between the absorbability of the radiation and the atomic weight of the radiator was found to be approximately a linear one for a long range of atomic weights on both sides of nickel. Nickel itself, however, can only be brought into line by giving it an atomic weight of about 61·3. A. W.

644. *Emission of Röntgen Rays.* **T. Alippi.** (N. Cimento, 12. pp. 347–348, Nov. and Dec., 1906.)—The author observed that the emission of Röntgen rays and the brightness of the fluorescence of a tube is greatly increased by breathing upon it. Further, he directed a jet of steam upon it, and found that the effect was enhanced to such an extent that the antikathode became red hot. Some portion of the current evidently passes outside the tube. No effect is produced by a jet of alcohol, ether, or sal-ammoniac, nor when the area impinged upon by the vapour is limited. E. E. F.

645. *Spectrum of Röntgen Rays from a Focus Tube.* **J. M. Adams.** (Amer. Journ. Sci. 23. pp. 91–92, Feb., 1907.)—The target in a Röntgen-ray tube is made in the form of a circular arc, the kathode rays are deflected upon it by a magnet, and since the Röntgen rays produced at different parts of the magnetic spectrum are caused by particles moving with different velocities, the quality of the Röntgen rays should vary. This is found to be the case. A metallic sheet shows selective absorption, and this does not follow the same law in all metals. R. S. W.

646. *Secondary Radiation produced by β-Rays.* **P. Dobler.** (Ann. d. Physik, 22. 2. pp. 227–245, Feb. 5, 1907.)—The rays pass through a slit and are bent by a magnet on to a photographic plate. This plate is covered with strips of platinum of different thicknesses, and the point is found on the plate for which the photographic action of the weakened primary rays and the secondary rays together equal that of the direct primary rays. The radius of the path of the rays is measured, and $RH = v/(e/m)$. Corresponding values of v and e/m are taken from Kaufmann's results to give the measured value of RH. Curves are given showing how the thickness varies with v. The results agree with theoretical conclusions of Paschen. R. S. W.

647. *Scattering of α-Rays by Metals.* **B. Kučera.** (Phys. Zeitschr. 8. pp. 103–107, Feb. 15, 1907. Phys. Inst. d. böhm. Univ., Prag, Jan. 2, 1907.)—Meyer explains the increase in absorption of the α-rays with the thickness of the absorbing substance as due to the decrease of velocity produced by successive layers [Abstract No. 63 (1907)]. He finds Kučera's supposition, that scattering is produced, unnecessary. The author now dissents from Meyer's conclusions, and criticises the method of reducing the observations.
R. S. W.

648. *Ultimate Disintegration Products of Uranium.* **B. B. Boltwood.** (Amer. Journ. Sci. 23. pp. 77–88, Feb., 1907. Contribution from the Sloane Phys. Lab. of Yale University. Phys. Zeitschr. 8. pp. 97–103, Feb. 15, 1907. Écl. Électr. 50. pp. 381–383, March 16, and pp. 447–449, March 30, 1907.)—The conditions essential for the identification of the final disintegration products of uranium from a study of minerals are the following: In unaltered primary minerals of the same species, and of different species from the same locality, *i.e.*, in minerals of equal ages, a constant proportion must exist between the amount of each disintegration product and the amount of the parent substance with which it is associated. The proportion of each disintegration product must also be greater in those minerals which are the older, and should correspond with the order of the respective geological ages of the localities in which the minerals have been found. As actinium is probably an intermediate product between uranium and radium, the field of search for final products is narrowed. The examination of various minerals here detailed places barium and bismuth out of the main line of descent of uranium and thorium. Lead, however, appears to fulfil the conditions defined above within the limits of experimental error, and may therefore be regarded as a final disintegration product of uranium. Helium is liable to escape if formed; the best test that we can apply then is to see whether the helium ever exceeds that calculated from the equation uranium (238·5) = lead (206·9) + helium (31·6). This is found never to be the case, and therefore helium may be looked on as a final product, since it is always present with uranium. Neither of these is a final product of thorium.
R. S. W.

649. *Effect of Temperature on Radio-activity.* **H. L. Bronson.** (Roy. Soc., Proc. Ser. A. 78. pp. 494–500, Feb. 2, 1907. Chem. News, 95. pp. 39–42, Jan. 25, 1907.)—Curie and Danne [Abstract No. 1360 (1904)] and Makower [Abstract No. 719 (1906)] have found that the decay of RaC is increased by high temperatures. Bronson has shown that the results of the former are due to the volatilisation of RaB [Abstracts Nos. 1586 (1905) and 307 (1906)]. He thinks that those of Makower are due to the design of his apparatus, since volatilisation of the active products will alter their distribution in the containing vessel, and this, with the dimensions used, would influence the observations. In the new apparatus a quantity of radium is heated in a small quartz tube by an electric resistance furnace; the activity, as measured by the γ-rays, is observed by an electroscope. This possesses the advantage that observations may be made while heating is going on. If any change in activity is observed, the author shows how we could infer in which product this has taken place. He concludes that if changes are produced they are less than 1 per cent. Low temperatures are also tried. The conclusion is arrived at that change in temperature has no effect on radio-active change.
R. S. W.

650. *Positive Charge of the a-Particle.* **F. Soddy.** (Nature, 75. p. 438, March 7, 1907.)—In a previous paper [Abstract No. 1710 (1906)] the author described experiments which led him to the conclusion that the α-particle as initially expelled is not charged. Subsequently published research has indicated that the α-particle may carry more than one atomic charge [see Abstract No. 1871 (1906)], and hence that the particle may not acquire its charge at one time. The author considers that this entirely alters the aspect of the question, and as he is unable to repeat or extend his work at the present time he desires to withdraw his observations previously published. S. G. S.

651. *Diurnal Periodicity of the Spontaneous Ionisation in closed Vessels.* **A. Wood and N. R. Campbell.** (Phil. Mag. 13. pp. 265–276, Feb., 1907.)—Both of the authors, when working independently, have been troubled by inexplicable variations in the current through closed vessels. A minimum appeared to occur in the afternoon [see Abstract No. 1097 (1906)]. This led to the present investigation. A vessel of the metal to be used is placed under a bell-jar which can be made gas-tight, and the ionisation inside it is measured throughout the day by means of an inwardly projecting electrode, using Bronson's method [Abstract No. 307 (1906)]. The results are given in curves. These show a minimum at 4 a.m., a maximum about 8 a.m., a second minimum about 2 p.m., and a second maximum at 11 p.m. The curves have not at present been analysed into Fourier series. In their main features they show a remarkable similarity to the curves representing the variations of atmospheric potential. It is hoped to establish a connection between the two. In addition to these periodic variations, it is found that the ionisation in a closed vessel undergoes a permanent increase for a considerable time after closing; this increase depends on the nature of the vessel, being large for tin and lead and negligible for zinc vessels. R. S. W.

652. *Helium in the Absence of Radio-activity.* **R. J. Strutt.** (Nature, 75. p. 390, Feb. 21, 1907.)—Beryl contains a quantity of helium of quite a different order of magnitude from what is found in ordinary inactive minerals. Thus 250 gm. gave 4·2 c.cm. of helium on heating; the mineral is altogether inactive. It seems possible that we have here a case of rayless change. R. S. W.

REFERENCES.

653. *Optical Device for Deflection Instruments.* **E. F. Northrup.** (Phys. Rev. 24. pp. 222–223, Feb., 1907.)—By employing two mirrors at 90° in the form of a < on the suspended coil of a galvanometer, the telescope and scale being superposed and pointed at the lower and upper mirror respectively (beam twice reflected), scale readings can be taken without their being affected even by considerable oscillations of the coil about a horizontal axis. L. H. W.

654. *Influence on Images of Gratings of Phase-differences amongst their Spectra.* **J. Rheinberg.** (Roy. Microscop. Soc., Journ. pp. 532–534, 1906.)—The phase-differences depend partly on the position of the grating on the stage of the microscope and also on the relative width of the slits to the bars. The effect is discussed under these two heads. G. E. A.

655. *Measurement of Lenses with the Abbe Spherometer.* **H. C. Lomb.** (Zeitschr. Instrumentenk., Beib. 2. pp. 15–17, Jan. 15, 1907.)—Explains an extension of the theory of the Abbe spherometer which is necessary when the instrument is applied to the measurement of lenses of large curvature. G. E. A.

656. *Zeeman Effect in Weak Magnetic Fields.* **E. Gehrcke** and **O. v. Baeyer.** (Deutsch. Phys. Gesell., Verh. 8. 20. pp. 399–404, Oct. 30, 1906. Paper read before the 78 Naturforscherversamml., Stuttgart, Sept. 18, 1906. Communication from the Physikal.-Techn. Reichsanstalt. Phys. Zeitschr. 7. pp. 905–907; Discussion, p. 907, Dec. 1, 1906.)—Some determinations of the value of *e/m* for the Mercury lines by means of Lorentz's formula—

$$\frac{e}{m} = \frac{4\pi c}{H\lambda^2}\sqrt{\delta\lambda_1 \times \delta\lambda_2},$$

where $\delta\lambda_1$ and $\delta\lambda_2$ are the wave-length differences between the outer and the middle components of the triplets. E. C. C. B.

657. *Sensitiveness of Ordinary Photographic Plates to Light and to Röntgen Rays.* **Blythswood** and **W. A. Scoble.** (Röntgen Soc., Journ. 3. pp. 38–41; Discussion, pp. 41–44, Dec., 1906.)—The experiments were made with rays of the same intensity throughout, and it is found that amongst plates of equal speed as regards exposure to light there are sometimes differences which cause the exposures required to the rays to have a ratio as large as 4 to 1. L. H. W.

658. *Röntgen Rays through Coins.* **C. Jensen.** (Ann. d. Physik, 21. 5. pp. 901–912, Dec. 14, 1906. Phys. Staats-Laborat., Hamburg, Aug. 30, 1906.)—The action of Röntgen or Becquerel rays on photographic plates through coins is investigated; the differences in the negatives produced seem to depend, apart from secondary rays, upon differences in the permeability of the different coins to the primary rays used. A. D.

659. *Presence of Rare Gases in Natural Mineral and Thermal Waters.* **C. Moureu** and **R. Biquard.** (Comptes Rendus, 143. pp. 180–182, July 16, and pp. 795–797, Nov. 19, 1906.)—Besides the presence of helium and argon previously established [Abstract No. 365 (1905)], the authors now confirm the presence of neon in 22 thermal springs. In the second paper, the quantity of helium found is given in a table for the different sources. The average yield is very small, but in the case of Maizières amounts to 6·39 per cent. of the evolved gases, where also the most definite sign of the presence of krypton was observed. L. H. W.

660. *Helium in Natural Gas.* **H. P. Cady** and **D. F. McFarland.** (Science, 24. p. 344, Sept. 14, 1906.)—The proportion of helium in the natural gas outflow struck at Dexter, Kansas, is found to amount to 1·84 per cent., thus providing a source of helium in practically unlimited quantities. L. H. W.

661. *Decay of Radium A, B, and C.* **P. Gruner.** (Ann. d. Physik, 22. 2. pp. 399–400, Feb. 5, 1907.)—The author makes several remarks concerning a previous paper on radio-active transformation [see Abstract No. 714 (1906)] and points out that his results arrived at by theoretical considerations agree to a certain extent with the experimental results of H. W. Schmidt [see Abstract No. 67 (1907)] in that there is a slightly penetrating radiation from Radium B, but he suggests that this may consist of *a*-rays and that more observations upon their deviation in a magnetic field are necessary in order to decide the matter. S. G. S.

HEAT.

662. *Simple Thermometer for Low Temperatures.* **A. Stock and C. Nielsen.** (Ber. Deut. Chem. Gesell. 39. pp. 2066–2069, 1906.)—The principle employed is to determine the tension which a small quantity of liquid oxygen possesses at the temperature to be ascertained. An oxygen-holder of about 25 c.cm. capacity is connected to a mercury reservoir, and the temperatures corresponding to the different tensions found are obtained from the tension curve, which is well known. Temperatures between —183° and —200° can be quickly determined, differences of 0·01° being detectable. Other gases can be employed for other temperature-ranges. L. H. W.

663. *Absolute Dilatation of Mercury.* **J. Joly.** (Roy. Dublin Soc., Proc. 11. 14. pp. 179–180, Feb., 1907.)—Accuracy within ⅜ per cent. in determining the mean expansibility between ordinary temperatures and 100° C. is obtainable by comparison of the simultaneous heights of an ordinary barometer and of one which, with its reservoir, is entirely steam-jacketed. The air above the reservoir is kept at atmospheric pressure by means of a tube communicating with the outside, and the top part of the Torricellian vacuum protrudes above the jacket so that the pressure of the mercury vapour may be kept at normal value. R. E. B.

664. *Specific Heat of Lithium and of Calcium.* **A. Bernini.** (N. Cimento, 12. pp. 307–316, Nov. and Dec., 1906. Phys. Zeitschr. 8. pp. 150–154, March 1, 1907. Translation.)—For lithium the following specific heats were found: 0·8366 at 0° to 19·3° C., 0·9875 at 0° to 78°, 1·0925 at 0° to 100°, 1·3215 at 0° to 157°. Regnault's value between 27° and 99° was 0·9408. For calcium the specific heat was found to be: 0·1453 between 0° and 20·3° C., 0·147 between 0° and 78°; 0·149 between 0° and 100°, 0·1521 between 0° and 157° C. Bunsen's value between 23° and 99° is in accordance with these results. D. H. J.

665. *Expansibility and Compressibility of Ether and Alcohol near their Boiling-points.* **A. W. Smith.** (Amer. Acad., Proc. 42. No. 17. pp. 421–460, Jan., 1907. Contribution from the Jefferson Phys. Lab., Harvard College.)—In order to investigate the values of a in van der Waals' characteristic it is important to know the expansibility and compressibility of a liquid just before it vaporises. To determine these it is necessary that but small variations of pressure and temperature should be employed, and ethyl ether and alcohol have been carefully examined, both just before reaching their boiling conditions and also when slightly superheated, electrical heating and measurement of temperature being employed. A full account of the method used is given, and the results are discussed with the collaboration of E. H. Hall. The values of both the expansibility e and compressibility k were found to be constant within the range of pressure employed, which means that the Thomson isothermal is continuous where it is cut by the saturation curve. The values of a, calculated on the assumption that $a/v^2 = Te/k - p$, agree with those obtained by extrapolation from Amagat's experiments, indicating continuity of the intrinsic energy of a liquid as it approaches and enters the

superheated state. The values also of $\rho/(d_1 - d_2)$ were calculated, where ρ denotes the internal latent heat of vaporisation and d_1, d_2 the densities in the saturated liquid and vapour states; these are less than the values of a at corresponding temperatures. Difficulty was experienced in bringing back ether from the superheated to the unsuperheated state by isopiestic cooling, sudden vaporisation occurring, but there was none in effecting the return by isothermal increase of pressure. R. E. B.

666. *Isometric Specific Heat of CO_2 under High Pressure.* **W. A. D. Rudge.** (Cambridge Phil. Soc., Proc. 14. pp. 85–89, March 6, 1907.)—The liquid CO_2 in sparklets becomes gas under 400 or 500 atmospheres when heated to 32°. The sparklets were placed with water in a calorimeter and heated [? to about 60° C.]; cold water was then added and the resulting cooling [? to not less than 32°] was noted. The isometric specific heat found varied from 0·40 to 0·68, the mean value being 0·59. Another method with electric heating, which seems to be better, was employed; this gave values from 0·418 to 0·508 for the isometric specific heat. This result is in agreement with Joly's observations, allowance being made for the high pressures employed. R. E. B.

667. *Specific Heat of Superheated Steam.* (Engineering, 83. pp. 227–228, Feb. 22, 1907.)—An article recounting the observations of Knoblauch and Jakob [see Abstract No. 353B (1907)] and of Bilbrough [see Abstract No. 433 (1907)], whose discussion of his experiments is, however, faulty. From the former the total heat of superheated steam, in B.Th.U. per lb., is calculated to be—

$$1050{\cdot}8 + 0{\cdot}445t + 0{\cdot}000026t^2 - 22{\cdot}8(t' - 212)/(t - t' + 150),$$

where $t°$ denotes its actual temperature F., t' the temperature F. at which under its actual pressure it would be saturated; and the characteristic for saturated steam is given as—

$$pv = 0{\cdot}593T - 63v^{-\frac{1}{3}}$$

when p is expressed in lbs. weight per sq. in. R. E. B.

668. *Evaporation from Water-surfaces.* **J. R. Sutton.** (Roy. Dublin Soc., Proc. 11. 13. pp. 137–178, Feb., 1907.)—Experiments on a large scale under meteorological conditions were carried out at Kimberley, the evaporation of water being examined from a Piche atmometer, a tub of 14 in. diam. and 18 in. depth, a circular tank of 46 in. diam. and 29 in. depth in the centre of a cistern 7 ft. square with which it did not communicate, vessels at the bottom of metal tubes of 3½ in. diam., and 1, 2, or 3 ft. depth, the instruments being in general in louvered screens. The results found do not agree with either Stefan's or Fitzgerald's formula, the former of which, with the results found, would indicate a practically constant rate of evaporation from sunrise to midnight and from month to month. The rate of evaporation is much greater between 8 and 11 a.m. than between 5 and 8 p.m., and it is greatest between 11 a.m. and 2 p.m.; it seems to depend further on the *relative* humidity, increasing as the relative humidity decreases, even though this implies a lower water-temperature. The temperature of the water is generally less during the day than that of the air, and it seems to be a

minimum when the air is about half-saturated. The general conclusion is drawn that while differences between the vapour pressures at the water-surface and in the open air are competent to influence the rate of evaporation to a large extent, their effect is profoundly modified by the relative humidity, and that however brightly the sun may be shining there will not be great evaporation unless the air be dry. Electrification did not seem to affect the rate of evaporation. R. E. B.

669. *Inversion-points of the Joule-Kelvin-effect for Air and Nitrogen.* **K. Olszewski.** (Acad. Sci. Cracovie, Bull. 9. pp. 792–796, Nov., 1906.)—The apparatus formerly used for hydrogen [see Abstract No. 858 (1902)] has been improved and arranged for employment with temperatures up to 300° C. The gas under investigation was allowed to expand from different initial pressures into the open air, *i.e.*, to the pressure of 1 atmo., its initial temperature under any given initial pressure being varied from 300° C. downward; the variation in temperature on expansion was measured by an iron-constantan element, and that temperature t° C. was noted for each given initial pressure p above which warming and below which cooling on expansion took place. For air a large variation of t was found with variation of p, viz.—

p	t	p	t
160	259	70	235
100	249	60	226
90	244	40	198
80	240	20	124

and the results for nitrogen were of the same kind, there being a drop of t from 243° to 163° for a drop of p from 159 to 30 atmos. The trend of the curve connecting p and t explains why the initial pressure in the apparatus for liquefying air should not be below 80 atmos. R. E. B.

670. *Ignition Temperatures of Hydrogen-Oxygen Mixtures.* **K. G. Falk.** (Amer. Chem. Soc., Journ. 28. pp. 1517–1534, Nov., 1906.)—Previous measurements of the ignition temperatures of detonating gas have given divergent results, since, when a sealed bulb of the gas is plunged into a bath of known temperature, or when the gas is passed through a tube heated to a certain temperature, the whole of the gas does not reach the ignition temperature at the same instant. In the method devised by the author the whole of the necessary heat is developed by the adiabatic compression of the gas itself in a steel cylinder fitted with a steel piston, the compression being so rapid as to preclude radiation of heat to the cylinder walls. The average ignition temperatures (degrees absolute), calculated from the equation for adiabatic changes, are as follows: For $4H_2 + O_2$, 898°; $2H_2 + O_2$, 819°; $H_2 + O_2$, 796°; $H_2 + 2O_2$, 808°; $H_2 + 4O_2$, 849° C. It is found that the ignition temperature is independent (1) of the final pressure of the gas for pressures greater than 39 atmos., and probably for much lower pressures, and (2) of the initial temperature of the gas. The fact that the mixture $H_2 + O_2$ has the lowest ignition temperature is probably owing to the first product of the union of hydrogen and oxygen being hydrogen peroxide, which may or may not be completely or partially decomposed, according to the conditions. The ratio of the pressure of the gas at the ignition point should, according to the theory of the explosion wave, be constant for any one mixture; this is approximately verified by the results. T. H. P.

671. *Explosive Wave.* **Crussard.** (Comptes Rendus, 144. pp. 417–420, Feb. 25, 1907.)—If by a brusque compression in a perfect gas normally under pressure P, and with specific volume V, a wave is propagated with speed U, the gas behind this having speed u and being compressed to $P + p$ and condensed to $V - v$, the equations of continuity, momentum, and energy are respectively—

$$u/U = v/V, \; p = uU/V, \; (P + p)u = \tfrac{1}{2}u^2U/V + [(P + p)(U - u) - PU]/(\gamma - 1),$$

whence Hugoniot's law, which in terms of the contraction $\omega \equiv v/V$ and the compression $\phi \equiv p/P$ is expressed by—

$$1/\omega - \gamma/\phi = \tfrac{1}{2}(\gamma + 1).$$

Displayed on a diagram this gives a hyperbola, from which the state of the gas can be at once graphically determined for any character of disturbance, the pressure being $P(1 + \phi)$, the specific volume $V(1 - \omega)$, the temperature $T(1 + \phi)(1 - \omega)$; also $U = \surd(PV\phi/\omega)$, $u = \surd(PQ\phi\omega)$, and the speed of sound $S = \surd(\gamma PV)$, γ being the tangent of the inclination to the ω-axis of the tangent at the origin. If a flame of complete combustion accompanies the wave of shock the above equation has the further term $-\epsilon/\omega\phi$ on the left-hand side, where ϵ denotes the compression in isometric adiabatic combustion. This gives another hyperbola, which shows that a wave of shock and complete combustion may have any velocity whatever above a certain minimum value. The geometrical relations of these curves make very easy the discussion of the properties of these waves. R. E. B.

672. *Critical Temperatures.* **J. Traube.** (Zeitschr. Phys. Chem. 58. pp. 475–478, March 15, 1907.)—A rejoinder to Travers and Usher's criticism [Abstract No. 83 (1907)] of Traube and Teichner's investigation [see Abstract No. 1099 (1904)]. He maintains that in no experiments have variations of temperature, and consequently of pressure, been more avoided than in those specially carried out by Teichner by use of special liquid thermostats; that the disappearance of the meniscus does not occur at the true critical temperature, that when cloudiness is no longer visible there are still differences of density which do not completely disappear till some degrees above the Cagniard de la Tour temperature, that the phenomena point rather to the existence of a critical interval than of a critical point. An explanation he finds in van der Waals' b being a function of the pressure, but he favours Bakker's hypothesis of the constitution of the surface-layer between the liquid and vapour phases. R. E. B.

673. *Relation between Absolute Temperature and Kinetic Energy of a Thermodynamic System.* **N. Schiller.** (Ann. d. Physik, 22. 8. pp. 578–578, March 5, 1907.)—Helmholtz has shown that the kinetic energy of a monocyclic system is an integrating divisor of the heat taken in by the system, and this conclusion has been tacitly extended to other systems. But it is here shown that, though true for simple monocyclic systems, it does not hold good for composite monocyclic systems unless, with the usual notation, the relations $\partial p_i/\partial T = c\partial\psi/\partial v_i$ are satisfied, where ψ is an arbitrary function of the parameters $v_1, \dots v_n$. The conditions do not hold good for fluids conforming to either van der Waals' or Clausius' characteristic or for a substance coexisting in two phases. R. E. B.

674. *Entropy.* **K. v. Wesendonck.** (Phys. Zeitschr. 8. pp. 154–158, March 1, 1907.)—Boltzmann's and Planck's suggested special definitions of entropy for the case of gases in motion are discussed, and it is concluded that nothing is gained by departure from Clausius' definition; that, though a definite temperature cannot be ascribed to a mass whose parts are not in relative equilibrium, such definite temperature can be ascribed to each group within it that is in equilibrium in itself, and that the entropy of the whole is properly given as the sum of the entropies of all the groups, each taken with its proper temperature. R. E. B.

675. *Validity of the Theorem of Thermodynamic Equilibrium.* **A. Einstein.** (Ann. d. Physik, 22. 3. pp. 569–572, March 5, 1907.)—It is generally assumed that an isolated system is in equilibrium when its defining parameters have values that make its entropy a maximum. But in actuality each parameter must be slightly oscillating about a mean value, and a calculation seems to show that work from outside equal to a third of the average kinetic energy of an atom is needed to produce the average variation of a parameter. The theory is applied to the case of a condenser which may become sensibly electrified by virtue of unordered molecular motions. R. E. B.

REFERENCES.

676. *Researches on Thermal Conductivity at Ordinary and at Low Temperatures.* **P. Macchia.** (Accad. Lincei, Atti, 15. pp. 620–630, Nov. 18, 1906.)—The only work so far published on this subject is that of Giebe (1903), who determined the thermal conductivity of bismuth at —180° C. The present author describes the theory of a method depending on the introduction of Stefan's law (instead of Newton's) into Fourier's equation. D. H. J.

677. *Specific Heat of Steam.* **R. H. Smith.** (Eng. Rev. 16. pp. 161–165, March, 1907.)—This is a destructive criticism of Bilbrough's paper [Abstract No. 433 (1907)] in which, apart from the assumptions underlying the method employed, the reasoning seems to be illogical in many points and inconsistent with the results obtained, so that the conclusions are untenable. R. E. B.

678. *Stability of the Explosive Wave.* **Crussard** and **Jouguet.** (Comptes Rendus, 144. pp. 560–563, March 11, 1907.)—The properties found by the former author for waves of shock and combustion are here refound and extended by the method employed by the latter [see Abstracts Nos. 1204 (1906) and 609, 671 (1907)] on the assumption that the combustion is incomplete in the wave, but behind the wave is completed adiabatically and reversibly according to the law of dissociation; it then appears that the explosive wave is stable and has a constant velocity. R. E. B.

679. *Spherical Waves of Shock and Combustion.* **Jouguet.** (Comptes Rendus, 144. pp. 632–633, March 18, 1907.)—The method applied to plane waves [see preceding Abstract] is here extended to spherical waves with the same assumptions, and the conclusion is reached that it is probably impossible for a wave to be propagated which has a speed which is at once uniform and independent of the conditions at the limits behind it. R. E. B.

680. *Non-homogeneous Mixtures.* **E. Bose.** (Comptes Rendus, 143. pp. 1227–1229, Dec. 31, 1906. Phys. Zeitschr. 8. pp. 87–89, Feb. 1, 1907.)—It is shown how a thermodynamic formula of Nernst may be applied to find the partial pressures of non-homogeneous mixtures as functions of the temperature. R. E. B.

SOUND.

681. *Maintenance of Vibrations by a Notable Impulse.* **V. Hensen.** (Ann. d. Physik, 21. 4. pp. 781–813, Nov. 27, 1906.)—Deals with the question of organ-pipes and the maintenance of their tones by the blast. In the phenomena concerned the author recognises specially (1) the *primary force*, the current in the blade-like stream of air at the mouth; (2) the *damping*; (3) the *vibrations maintained*, the secondary currents and the consequent variations of density; (4) the *impulse* which sustains the vibrations in spite of the damping. This impulse is traced to the circumstance that the inward direction of the blade-shaped stream of air lasts just a trace longer than its outward direction. Both flue and reed pipes are dealt with, and the paper is illustrated by a number of figures, curves, and tabulated results. [See also Abstract No. 2196 (1900).] E. H. B.

682. *Singing Flames excited by Aerial Vibrations.* **K. Marbe.** (Phys. Zeitschr. 8. pp. 92–93, Feb. 1, 1907. From the psycholog. Inst. d. Akad., Frankfurt.)—Previous work with König flames suggested to the author the possibility of exciting the vibrations of one flame by those of another, the air surrounding them being the only connecting medium through which the waves were propagated. This he has now accomplished. A König flame was connected with a telephone and the alternating current of the town supply; the simple flame was at a distance of 8 to 20 mm. away, and vibrated in response to the other. Its vibrations were detected and recorded by passing a strip of paper along so as to be smoked by it. Regular patterns were thus obtained, which are illustrated by photographs accompanying the paper. [See also Abstract No. 1741 (1906).] E. H. B.

683. *Acoustical Notes.* **Rayleigh.** (Phil. Mag. 13. pp. 316–333, March, 1907.)—This communication deals with a number of separate subjects as follows: (1) An arrangement of *telephones and a revolving magnet* is described to further test the mechanism of our right and left sensation in the case of binaural audition. The magnet was set in rotation at 190 per sec. by a small turbine and wind at about 2 in. water pressure, the note thus produced by induction in two coils and connected telephones being *g*. The results are confirmatory of those with the tuning-forks [see Abstract No. 444 (1907)], but in the present arrangement the advantage is secured of keeping any desired phase-change constant or suddenly altering it by 180° on reversal of a commutator. (2) *Multiple harmonic resonators* are next dealt with. These may be of the usual König pattern, but changed in pitch by shading the aperture with the finger. The idea is then carried out more completely by providing a resonating chamber with a number of separate apertures, any or all of which may be completely closed with the fingers. The openings for the fundamental and octave have necks of brass tubing; six other openings are simply holes in the sheet zinc which forms the resonator, in shape an elliptical cylinder and of capacity 140 c.cm. The simple theory applicable to such resonators is given in the following equations: $2\pi N = a\sqrt{c/S}$ ... (1), where N is the frequency, *a* is the velocity of sound in air, S the volume included

in the resonator, and c the electrical conductivity between the interior and the exterior, calculated upon the supposition that air is a conductor of unit specific conducting power, and that the walls behave as insulators. For a circular aperture in a thin wall c is equal to the diam. of the aperture. If there are several apertures well separated from each other c is given by the sum of the diameters or $c = d_1 + d_2 + d_3 + \ldots$ (2). Thus for the harmonic series of frequencies 1, 2, 3, &c., we have $d_1 : (d_1 + d_2) : (d_1 + d_2 + d_3) = 1 : 4 : 9$, or $d_1 : d_2 : d_3 \ldots = 1 : 3 : 5 : \ldots$ (3). When the opening has a neck of radius R and length L we have $c = \pi R^2/(L + \frac{1}{2}\pi R) \ldots$ (4). (3) *Tuning-forks with slight mutual influence* may be arranged by driving each independently in the usual electromagnetic manner, but setting the prongs of each fork over one hole of a suitable two-holed resonator. A more powerful controlling reaction follows when the two forks are connected by a slender cotton thread pulled into a Y-shape by a third thread under slight tension. The Lissajous' figure is then stationary and usually open. (4) *The mutual reaction of singing flames* may be observed by two exactly similar arrangements of hydrogen bottles, jets, and tubes, when less than 80 cm. apart. At greater distances beats may be heard between them on shading one with the finger, but at 8 or 10 cm. apart a difficulty is experienced in producing slow beats. On the margin where beats still occur, their character is peculiar. They appear unsymmetrical, the swell being protracted and the fall hurried. When the pipes are close together even moderately slow beats are excluded. In this situation the sound is much attenuated, indicating that the phases of vibration are opposite, at any rate in the ideal case. (5) *The isolation of the prime tone of a tuning-fork* was the object of a series of experiments, which showed that the introduction of loads *inside* the prongs near their ends nearly secured this object. (6) *A tuning-fork siren* was used in 1901 as a substitute for the usual reed and horn of the Trinity House "Manual" Foghorn. The tuning-fork was electrically driven, and its prongs vibrated laterally so as to alternately open and close an aperture through which the blast was directed. It is now recorded that the fork, after being once started, remained in vigorous vibration under the action of the *wind alone*, although the electrical connection was cut off. It is pointed out that this case is altogether different from that of a reed, where the tongue approaches and recedes from the aperture normally. It is more analogous to the Æolian harp, where, as formerly shown by the author, the vibration is executed in a plane perpendicular to the direction of the wind. (7) *Stroboscopic speed regulation* and (8) *the phonic wheel and commutator* are also dealt with, the explanations being accompanied by illustrative diagrams.

E. H. B.

REFERENCE.

684. *Absolute Intensity of Sound.* **V. Dvořák.** (Ann. d. Physik, 22. 3. pp. 606–608, March 5, 1907.)—In the work on this subject by W. Zernov there was quoted the method of the present author for obtaining the excess pressure at a node of stationary waves [see Abstract No. 2054 (1906)]. This method is here further explained and a possibility of wrongly using it and so obtaining a false measurement is pointed out.

E. H. B.

ELECTRICITY AND MAGNETISM.

THEORY, ELECTROSTATICS, AND ATMOSPHERIC ELECTRICITY.

685. *Electromagnetic Mass.* **A. W. Conway.** (Roy. Dublin Soc., Trans. 9. 5. pp. 51–58, March 28, 1907.)—An endeavour to give a compact mathematical scheme of electrodynamics developing all from the single principle of action and reaction, or "the internal electromagnetic forces of an electrical system are in equilibrium with the external electromagnetic forces." Expressions for momentum and energy are then obtained, and also for retarded potential and coefficients of induction. "Mass," in any direction, is then defined to be the resolved part of the opposing force along the unit acceleration in that direction, and is shown to be inversely proportional to the square of the corresponding radius vector in that direction of what is termed the *mass-quadric.* E. H. B.

686. *Mechanical Forces in Electrostatic and Electromagnetic Fields.* **O. Colard.** (Assoc. Ing. El. Liége, Bull. 6. pp. 277–313, Aug.–Sept.–Oct., 1906.)—In the first section the author considers "static fields" both electrostatic and electromagnetic. He defines a static field to be one which is independent of the time. Maxwell has shown that "action at a distance" between magnetic poles or electrostatic charges may be replaced by actions communicated from point to point. The author has considered this question in detail, and develops it on the lines laid down by Vaschy. He finds expressions for the longitudinal tension and the lateral compression of tubes of force in isotropic media, and for the force exerted by a magnetic field upon a current. He also considers the case of æolotropic media. He concludes that in the case of the armature or field magnets of a dynamo or motor the forces due to the non-uniform nature of the field are normal to the surfaces of separation (the permeability is supposed to be constant). The resisting or useful force giving rise to the torque is not the force exerted upon the surface of the cylinders which have the axis of rotation for their axes, although the lines of force may fall obliquely on them and undergo refraction. The forces giving rise to the couple can only act on surfaces which are not parallel to the direction of motion. Hence these forces act on the sides of the slots, the tunnels, or the sides of the polar pieces. In the second section a *résumé* is given of the principles of the theory of the variable electromagnetic field, and expressions are found for the forces exerted on the sides of an elementary parallelopiped due to any electromagnetic disturbance. In the particular case of plane harmonic waves it follows that the medium is subjected to a periodic force which acts in the direction of the propagation of the wave and the frequency of which is double that of the wave. A. R.

687. *General Theorems in Electrotechnics.* **H. Poincaré.** (Écl. Électr. 50. pp. 293–301, March 2, 1907.)—The author considers a system consisting of fixed circuits, movable circuits, and rotating circuits receiving current by rings. He first supposes that there are no permanent magnets, no commutating circuits of variable resistance, no appreciable capacity, and that

it does not receive direct current from an external source. In this case, no matter how complicated the system may be in other respects, a rigorous proof is given by means of the Lagrange-Maxwell equations that this system can never act like a self-exciting dynamo. He also proves that if alternating current be supplied to it the current will always lag behind the e.m.f. If a direct current be applied to this system of circuits (no commutator), it cannot act as a motor, although, of course, it can act as a simple alternating-current generator. The above theorems are no longer true when permanent magnets are present. We may regard the magnetic flux of the magnets to be due to molecular current circuits of zero resistance and in which no e.m.f. acts (Ampère), and so we can no longer conclude that the average value of the currents is zero. When condensers are present it is possible to make the machine self-exciting at a particular speed. At this speed the average electrostatic energy of the condensers equals the average electromagnetic energy of the currents. When there is a commutator the resistances are no longer constant and the above theorems no longer hold. It is shown, for instance, that Barlow's wheel is equivalent to a commutator with an infinite number of bars.

A. R.

688. *Theory of the Condenser.* **W. Kaufmann.** (Phys. Zeitschr. 8. pp. 75-78, Feb. 1, 1907.)—In experiments on the magnetic and electric deflection of electrons it is necessary to know accurately the integral value of the electric field traversed by an electron when flying through between the parallel plates of a condenser. Maxwell's and Kirchhoff's formulæ only deal with the case where the condenser is far removed from other material. The author calculates the field in the case of a condenser bounded by conducting plates on both sides, parallel to the axis of the condenser and separated from the edges of it by a small interval b. These plates are supposed to be earthed. Then, if the plates are thin, the amount by which their width must be theoretically increased on both sides to allow for additional field outside is $b - a\,[0{\cdot}442 + 0{\cdot}637/(k-1)]$, where $2a$ is the distance between the plates, and k a function of b and a according to the equation—

$$\pi b/a = \log\left[(\sqrt{k}+1)/(\sqrt{k}-)\right] + 2\sqrt{k}/(k-1).$$

If $a/b = 1{\cdot}79$, $k = 6{\cdot}5$, and the correction becomes zero. If the plates are thick in comparison with their width, the correction becomes—

$$\frac{1}{\pi}\left(2b\tan^{-1}(a/b) - a\log\frac{4a^2}{a^2+b^2}\right).$$

In this case the correction becomes zero when $a/b = 1{\cdot}89$. The author refers back to his work on the constitution of the electron, in which the field integral was empirically determined. The correction should have been 0·71 mm. instead of 0·67 mm., but the difference is of no practical importance. The author extends his reasoning to a cylindrical condenser completely enclosed by conducting surfaces, and determines the corrections applicable to the length of the inner cylinder to compensate want of uniformity of the field.

E. E. F.

689. *Behaviour of Aluminium Leaf in an Electrostatic Field.* **E. Bandl.** (Phys. Zeitschr. 8. pp. 114-117, Feb. 15, 1907.)—Several experiments are described in which small pieces of aluminium-foil suspended in an electric

field undergo oscillations in the direction of the field. The explanation given is that the brush discharge from the points causes a balance of charge of one sign to be acquired, which process is reversed when the particle is displaced by the force then acting on it. S. G. S.

690. *Atmospheric Ionisation.* **E. v. Schweidler.** (Akad. Wiss. Wien, Sitz. Ber. 115. 2a. pp. 1263–1284, Oct., 1906. From the II. phys. Inst. d. k.k. Univ., Wien.)—This paper describes researches on atmospheric electricity made in the summer months of the years 1902 to 1905. The object of the experiments described was (1) to determine the effect of varying meteorological conditions, and (2) to measure the electric conductivity absolutely by a special form of Gerdien's apparatus. The discharge rate was measured by an Elster-Geitel apparatus without a guard cylinder. The daily mean was obtained by compounding observations by means of the formula $q = (1/n)\Sigma(Z_-/Z_+)$, where Z is the rate of loss of charge in volts per 5 min. of a body at a potential of 200 volts. The results from most of the places of observation show maxima at night and midday, and minima at sunrise and sunset. Clear days show a marked deviation from the mean value, q being somewhat lowered. Stormy days give a noticeable increase in the morning hours. The variation of atmospheric pressure does not seem to affect the mean value much, but in the morning a fall in pressure is accompanied by a rise of Z and *vice versâ*. As a result of the conductivity measurements, it was concluded that the rate of discharge is directly proportional to the conductivity. The conductivity was found (for $Z = 48{\cdot}9$) to be given by $\lambda = \lambda_+ + \lambda_- = 4{\cdot}44 \times 10^{-4}$ sec.$^{-1}$. [See also Abstract No. 1091 (1906).] A. W.

691. *Atmospheric Radio-activity.* **K. W. F. Kohlrausch.** (Akad. Wiss. Wien, Sitz. Ber. 115. 2a. pp. 1321–1326, Oct., 1906. From the II. phys. Inst. d. k.k. Univ., Wien.)—The author describes a method for the absolute measurement of radio-active induction in the atmosphere. Previous work on the subject is discussed. [See Abstracts Nos. 799 (1903), 783, 835, 1485 (1904), 786 (1905), 186 (1906).] The apparatus used was essentially an Ebert aspiration apparatus of considerably increased size, the tube used, through which air was drawn, being 100 cm. long and 16 cm. diam. This was placed horizontally and fastened to the neck of an Exner-Elster-Geitel aluminium-leaf electrometer. To the part of this which carried the leaves was fastened a T-piece whose straight top part (30 cm. long) was central and parallel to the tube. This T-piece was charged to a potential of about −200 volts. Three such pieces were used, of exactly identical size, shape, and material, and observations were taken with these in the early morning, at midday, and in the evening. The capacity of the apparatus was 19·8 cm., and air was drawn through at the rate of 0·05 m.^{3} per sec. The potential loss before aspiration was 10 volts in 48 min. If t_1 is the time for which air is drawn through the tube, ϕ the volume of air in m.^{3} per sec., λ the dissipation-constant, and ϵ the saturation current corresponding to the carriers in 1 m.^{3} of air. Then M_1, the strength of the induction on the T-piece, is given by—

$$M_1 = \epsilon\phi\int_0^{t_1} e^{-\lambda(t_1-x)}\,dx = \frac{\epsilon\phi}{\lambda}\left(1 - e^{-\lambda t_1}\right).$$

The value for the constant λ has been found to be $4{\cdot}1 \times 10^{-4}$, and therefore is equal to that for radium C. The strength M_1 diminishes during the time of observation t_2, so that the effective strength for the whole time t_2 is given by $M_2 = \frac{\epsilon\phi}{\lambda}(1 - e^{-\lambda t_1}) \int_0^{t_2} e^{-\lambda t}\, dt = \frac{\epsilon\phi}{\lambda^2}(1 - e^{-\lambda t_1})(1 - e^{-\lambda t_2}) = \frac{C.V}{300}$, where C is the capacity, and V the potential-fall in volts per sec. of the induction strength M_2. ϵ is reckoned in electrostatic units. The mean of all results gives a value for ϵ of $0{\cdot}5 \times 10^{-5}$, which is therefore 20 to 200 times smaller than the value obtained by Eve and Hofmann by indirect observations. As regards the effect of weather conditions, the author found that increased humidity gave corresponding increased values of the inductions—a result also found by Simpson. The daily variation showed a maximum at night and minimum at midday. No connection between the induction yield and the direction of wind could be determined, but clouds seem to have a considerable effect. With a cloudless sky ϵ had the value (mean of 19 observations) $6{\cdot}1 \times 10^{-6}$; with a cloudy sky the value was $4{\cdot}88 \times 10^{-6}$ (12 observations), and after rain was only $3{\cdot}25 \times 10^{-6}$ (6 observations). Variation of the barometric pressure has also an effect, a falling pressure giving a greater value for ϵ than either stationary or rising pressures. With a falling pressure, 10 observations gave a mean value of $6{\cdot}29 \times 10^{-6}$; with pressure stationary 13 observations gave $5{\cdot}3 \times 10^{-6}$, and with the barometer rising the value was $4{\cdot}41 \times 10^{-6}$. A. W.

692. *Dissipation of Electricity and Radio-activity in the Bin-Basch-Choba Cave, Crimea.* **E. Leyst.** (Soc. Imp. Nat. Moscow, Bull. 1 and 2. pp. 191–200, 1906.)—The cave is situated in the Tschadyr Dagh, 1,003 m. above sea-level. The entrance is low and narrow; the two main halls are connected by a long, winding passage; there is no water-basin in the cave and no outlet. Visitors are rare; torches are not used for lighting, only candles. The dissipation was, in July, 1905, for negative charges 40 times greater in the cave than outside in the open air, for positive charges 57 times greater. The author used an Elster-Geitel apparatus made by Günther and Tegetmeyer. The radio-activity was determined (method and instruments by the same) by exposing a copper wire 30 m. in length, 0·46 mm. in diam., suspended from insulated hooks on iron poles, 10 m. high. As the dissipation in the cave was abnormally rapid, and 46 min. elapsed before the radio-activity of the coiled-up wire could be determined outside, after an exposure of 2 hours in the cave, the following values for the a due to radio-activity (which make allowance for the dissipation) are somewhat uncertain: At Yalta (sea-shore) $a = 18{\cdot}7$, at Ai-Petri $a = 26{\cdot}3$, in cave $a = 28{\cdot}5$, on the Tschadyr-Dagh, 1,525 m., $a = 32{\cdot}2$. The a therefore increase with the elevation, or possibly with the distance from the sea. As regards the suggestion by Caspari and others, that high ionisation of the air might be responsible for the mountain-sickness, the author remarks that he arrived in the cave in a very feeble state, but did not feel any mountain-sickness. H. B.

DISCHARGE AND OSCILLATIONS.

693. *Electrified Centres in Flame Gases.* **M. de Broglie.** (Comptes Rendus, 144. pp. 563–565, March 11, 1907.)—Flame gases contain centres electrified in both senses, which differ from the ions due to Röntgen rays in (1) small velocity, tending as the gases cool to 0·005 mm. in a field of 1 volt/cm. ($\frac{1}{3000}$ that of Röntgen-ray ions), and (2) their producing condensation of water-vapour under very feeble supersaturations. It is as if a charged

ion had neutral particles agglomerated with it. The production of such systems does not take place where the products of combustion are wholly gaseous (flame of carbon monoxide) with filtered and dry gas and air supply; but where H_2O-vapour is formed in a gas within which there is a chemical action, radium radiations, or Röntgen rays, these systems are formed. The presence of such centres is associated with the formation of solid or liquid products or the antecedent existence of such centres in the air supply.

A. D.

694. *Ionisation of Air by Phosphorus* (*Emanation*). **R. Schenck, F. Mihr,** and **H. Banthien.** (Ber. Deut. Chem. Gesell. 39. pp. 1506–1521, 1906.)—The cause of the conductivity of the air in the neighbourhood of white phosphorus is found to lie, not in the oxidation product as such, but in the presence of an oxidation-product of phosphorus (phosphorus trioxide). Substances which prevent oxidation also prevent the appearance of the conductivity effect, since they prevent the formation of the oxidation product; but they are unable themselves to influence the ionisation. Red phosphorus also gives the "emanation" of phosphorus. L. H. W.

695. *Electrical Conductivity of Air.* **A. W. Ewell.** (Amer. Journ. Sci. 22. pp. 368–378, Nov., 1906. Phys. Zeitschr. 7. pp. 927–930, Dec. 15, 1906. Abstract.)—Studies the conductivity of air, self-ionised in a strong electric field, in connection with the Siemens ozoniser. Volts are plotted as abscissæ and milliamps. as ordinates. The lower portions of the curves show the well-known rapid increase of current with slight increase of potential, while the upper portions show that as the ionisation current in the air increases the e.m.f. necessary to maintain the current decreases. And further, as the current increases, the curves for the different distances approach each other. The reduction in the electric force when the electrodes are separated is compensated by the increased volume in which ionisation occurs. In other words, the air exhibits a so-called negative resistance, as in the arc discharge. The power absorbed in an ozoniser does not increase proportionally with increasing distance or current, and is independent of the thickness of the glass interposed between the electrodes. In the author's experiments the current was of the order of 7 milliamps., and the number of ions per c.cm., calculated from a particular case, was $1{\cdot}3 \times 10^{10}$. The proportional ionisation of the molecules is hence $2{\cdot}7 \times 10^{-10}$, or about 3 in 10,000 million. E. E. F

696. *Spark-potentials in High Vacua.* **E. Madelung.** (Phys. Zeitschr. 8. pp. 68–72, Feb. 1, 1907. Écl. Électr. 50. pp. 346–348, March 9, 1907.)—According to Paschen's law as developed by J. J. Thomson, the spark-potential at very low pressure p between two plane electrodes a very small distance d apart is inversely proportional to the product pd. If p is 1 mm. Hg and $d = 1$ mm., the spark-potential in air is about 2,000 volts. On reducing the pressure to 0·01 mm. Hg we should therefore expect a spark-potential of some 200,000 volts. The author's experiments prove, however, that nothing approaching such an excessive voltage is required to force the discharge across between slightly convex electrodes. All the indications observed go to show that in the higher vacua the spark-potential tends towards a maximum of about 40,000 volts with $d = 1$ mm. This maximum does not vary inversely as d, but is directly proportional to it. When one of the plates is replaced by a point, the spark-potential is considerably increased. The author suggests that the discharge is facilitated in the higher vacua by multiple reflection of

the electrons at the anode, which offers them additional chances of ionising the gas. But although brass and aluminium have different reflective powers it is immaterial which of them the anode is made of. **E. E. F.**

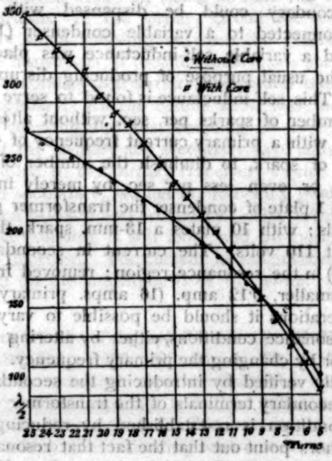
697. *Singing Arc in a Circuit without a Natural Period of Oscillation.* **M. La Rosa.** (Accad. Lincei, Atti, 16. pp. 112–121, Jan. 20, 1907.)—In the study of the singing arc it has generally been assumed that it is necessary that the shunt circuit should be of such electrical dimensions as to give it a natural period of free oscillation. It has, however, been noticed that the period of oscillation depends to some extent on the length of the arc, and even on the feeding current, and by no means wholly on the electrical constants of the system. This behaviour, which has been brought out by the researches of Simon [Abstract No. 1428 (1906)], leads one to suppose that the arc may serve not only to supply the energy dissipated in the shunt circuit, but may also be a controlling factor in the production of the oscillations. The electrostatic energy initially accumulated in the condenser divides itself during the discharge into three parts: The first in virtue of the inductance of the circuit is transformed into electromagnetic energy, the second is absorbed by the arc, and the third dissipated by the ohmic resistance of the circuit. Now, in order that the oscillations may be permanent, it is necessary that the arc should be able to give back some of the energy it has absorbed and, in addition, make up for the other losses. It has thus two functions: firstly, to store some of the energy given to it by the condenser, and, secondly, to supply from its own energy the dissipational losses. It is evident that in the first of these functions it is analogous to an inductance, and that, therefore, it renders oscillations possible in a circuit whose electrical dimensions are such as to preclude the possibility of a natural free vibration. The mathematical limits of free oscillation in the shunt circuit are next considered, and it is shown that in certain cases in which oscillations had been observed and measured, the dimensions of the circuits indicated that no free period existed. The entire circuit was next taken into account, but with a similar result. The conclusion is, therefore, arrived at that the production of oscillations is independent of the power of the circuit to oscillate freely, and is mainly due to the direct action of the charge and discharge of a condenser placed as a shunt across the arc. **J. E.-M.**

698. *Passage of Hertzian Waves through Gratings.* **G. H. Thomson.** (Ann. d. Physik, 22. 2. pp. 365–390, Feb. 5, 1907. Extract from Dissertation, Strassburg.)—If a plane-polarised wave falls upon a grating, we can resolve it into two components: one parallel and one perpendicular to the wires of the grating. As the formula by H. Lamb shows, the perpendicular component is transmitted with but slight diminution, only a small portion of it being reflected. On the other hand, a large part of the parallel component is reflected and very little transmitted. These theoretical deductions are here quantitatively subjected to experiment, the results being as follows: (1) The transparency of a grating for *damped* plane waves is somewhat smaller than Lamb's formula gives for undamped waves. (2) For diverging waves the transparency is increased. (3) The transparency of some gratings made from solutions was examined as a function of the conductivity. These gratings reflected but little. (4) The elementary waves of a damped wave suffer rotatory dispersion when incident upon a grating inclined at 45° to the direction of polarisation. From Lamb's formula an expression for the dispersive power of a grating may be derived, with which the experimental

results are in good agreement. (5) With the assumption that the waves are undamped, the phase-difference between the two components (parallel and perpendicular to the wires) may be inferred from the experiments and also derived from Lamb's formula. Here only a qualitative agreement obtained, but part of the discrepancy might be due to the neglect of the damping.

E. H. B.

699. *Electric Oscillations in Coils with Metallic Cores.* **J. S. Sachs.** (Ann. d. Physik, 22. 2. pp. 310–320, Feb. 5, 1907. Écl. Électr. 50. pp. 394–396, March 16, 1907.)—The author finds that, contrary to Drude's theory and experimental results, the introduction of a conducting core into a coil forming part of an oscillating circuit may cause an increase of the natural wave-length. Thus, with a coil of 18 turns of wire on an ebonite tube 4 mm. thick and 28 mm. in diam., the wave-length increased from 480 to 600 cm., on the introduction of a hollow brass cylinder. The intensity of the oscillation decreased slightly, though not to any appreciable extent. The annexed Fig. shows the course of a series of experiments in which the number of windings in the coil was altered step by step. Experiments were also made on the effects of introducing a liquid core, and in general with like results.



J. E.-M.

700. *Study of High-frequency Oscillations by means of Braun Tube.* **E. L. Weber.** (Electrical World, 49. pp. 507–508, March 9, 1907.)—An attempt was made by the author to delineate the wave-form of the high-frequency discharge from a Tesla transformer by using a Braun tube, whose kathode rays were simultaneously deflected along two mutually perpendicular directions, the deflection along one direction being produced by the electrostatic field between two plates connected to the secondary of the Tesla transformer, while the deflection at right angles to this was arranged to be proportional to the time, and was produced by a solenoid, to which a continuous e.m.f. was applied at the instant when a break occurred in the primary of the transformer, whose secondary was across the spark-gap in the primary of the Tesla transformer. The simultaneous make in the one circuit and break in the other were produced by means of two rotating commutators mounted on the same shaft. The time during which the "make" lasted in the circuit of the deflecting solenoid was so brief in comparison with the time-constant of the circuit, as to warrant the assumption of a rectilinear law of rise of current. No record of individual waves was obtained, but the logarithmic envelope of the train was clearly traced. A. H.

701. *Resonance in Open-circuit Transformers.* **G. A. Hemsalech** and **C. Tissot.** (Comptes Rendus, 144. pp. 262–264, Feb. 4, 1907. Ind. Élect. 16. pp. 90–91, Feb. 25, 1907. Électricien, 33. pp. 139–140, March 2, 1907.)—The authors describe experiments made with a transformer having an open magnetic circuit, and in which heavy insulation between primary and secondary could be dispensed with. The secondary terminals were connected to a variable condenser (10 plates, each of 0·00115 mfd.), and a variable self-inductance was placed in series with the primary, for the usual purpose of producing disruptive sparks and of stopping arcing. This self-inductance is found to serve further as a means of varying the number of sparks per sec. without altering the resonance conditions. Thus with a primary current frequency of 42 it is possible, for any given length of spark, to diminish the number of discharges of the condenser to one or even less per sec. by merely increasing the self-inductance. With 1 plate of condenser the transformer gives a 8-mm. spark between 2-cm. balls; with 10 plates a 13-mm. spark, the primary current being 22 amps., at 110 volts. The current in secondary was 0·23 amp. (20 amps. primary) in the resonance region; removed from this region the output is much smaller, 0·12 amp. (16 amps. primary, 4 plates). From theoretical considerations it should be possible to vary the capacity, still keeping within resonance conditions, either by altering the self-inductance of the secondary or by changing the primary frequency. The first point has been experimentally verified by introducing the secondary of a Rochefort coil between the secondary terminals of the transformer and the condenser. The resonance condition is re-established by reducing the capacity (to 1 plate). The authors point out that the fact that resonance in open-circuit transformers thus practically depends only on the self-inductance of the secondary is of value for wireless telegraph purposes. For spectroscopic work with conical electrodes only a very small primary current is needed. L. H. W.

702. *Coupled Condenser Circuits.* **C. Fischer.** (Ann. d. Physik, 22. 2. pp. 265–286, Feb. 5, 1907. Extract from Dissertation, Strassburg. Écl. Électr. 50. pp. 319–322, March 2, and pp. 360–368, March 9, 1907.)—The author has investigated experimentally the phenomena of the periods and damping in three coupled circuits. He finds that if N be the frequency in the primary circuit and n_1, n_2, the frequencies of the induced current in the secondary circuit, the theoretical relation $1/n_1^2 + 1/n_2^2 = 2/N^2$ is confirmed by experimental results in cases of both small and large damping-coefficients. The theoretical values of the decrements of these secondary oscillations, however, do not agree with practical determinations. Theory indicates that if δ_1 and δ_2 be the damping-coefficients of the oscillations n_1, n_2 in the secondary circuit and δ_A, δ_B the decrements of the primary and secondary, when separate, then $\delta_1 = [(\delta_A + \delta_B)/2](n_1/N)$, $\delta_2 = [(\delta_A + \delta_B)/2](n_2/N)$. Experiments show that these equations are incorrect, as they give results which are not

even qualitatively in agreement with observations. It is not true in general that the decrement of the oscillation of high frequency is greater than that of the other; in fact, the reverse is usually the case. The actual values of the decrements are found to be greater than theory indicates. Investigation was also made of the effect of varying the coupling on the (1) maximum amplitude of the secondary current and (2) on its r.m.s. value. It was found that the amplitude increased very rapidly with increasing coupling, then became slightly less and again increased. The greater the damping the flatter the maximum and the greater the coupling required to produce it. As regards the r.m.s. current, the following results were obtained. The current increases rapidly with the coupling and reaches a maximum while this is still small. It then decreases slightly, and afterwards remains nearly constant. In wireless telegraphy the receiver forms a third circuit, and though the author's experiments were made on *closed* circuits the results must be to some extent comparable. In the tertiary circuit the maximum current is reached with a very small coupling between the primary and secondary which represent the transmitter, it then decreases considerably. The greater the damping in the secondary and tertiary, the greater must be the coupling of primary and secondary. All the results show that there is a maximum useful value of the coupling, and that coupling closer than this is actually harmful. Finally, if the primary and secondary have constant damping and are very loosely coupled to the tertiary (receiver) circuit whose damping is equal to that of the secondary, we get the following phenomena on varying the coupling between primary and secondary. The tertiary current reaches a maximum while the coupling is still loose, and, on increasing, the coupling soon commences to decrease. The current in the secondary next reaches a maximum, and later on the amplitude does the same. [See also Abstract No. 573 (1906).] J. E.-M.

703. *Resonance in Wireless Telegraph Circuits.* V. **G. W. Pierce.** (Phys. Rev. 24. pp. 152–180, Feb., 1907. Electrician, 58. p. 980, April 5, 1907. Abstract.)—The author examines experimentally the wave-lengths of condenser circuits, first when separate and then when coupled—(*a*) inductively coupled, and (*b*) direct coupled. The wave-meter employed was that of Dönitz, but in which the indicating instrument was replaced by the high-frequency galvanometer described in Parts I. and II. [Abstracts Nos. 2688B (1904) and 1274 (1905)]. The wave-lengths employed were within the range 200–2,000 m. The experimental results are fully given, and should be referred to for details and the curves. It is concluded from the results that the ordinary theoretical formulæ are sufficiently accurate to be used for computing the wave-lengths in coupled condenser circuits; further, that the values of the coefficient of coupling required in the equations are given sufficiently accurately by measurements of self and mutal inductance with the ordinary bridge method (frequency 500–1,200 per sec.). The good agreement between observed and calculated values shows that the wave-meter is correctly calibrated, and it is proposed to use this wave-meter in further measurements with actual wireless telegraph circuits. [See also Abstract No. 757 (1906).] L. H. W.

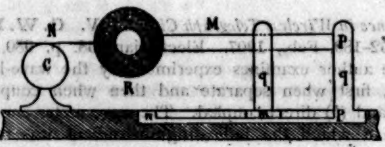
ELECTRICAL PROPERTIES AND INSTRUMENTS.

704. *Photo-electric Fatigue of Zinc.* **H. S. Allen.** (Roy. Soc., Proc. Ser. A. 78. pp. 483–493, Feb. 2, 1907.)—The observations on the decay of the activity begin 2 min. after the surface is polished. The activity falls rapidly for the first few min., afterwards more slowly; it can be very accurately represented by a formula of the type $I = K_1e^{-\lambda_1t} + K_2e$. The constants λ_1 and λ_2 represent, as in the equations expressing radio-active changes, the transformation constants or velocity-coefficients of the changes. To explain the results, it is assumed that freshly polished zinc (A) gives out negative ions under the influence of ultra-violet light, and changes into another form (B). This also emits negative ions while changing into a third form (C) which is supposed inactive. An equation expressing the activity at a time *t* is then deduced, this is—

$$I/I_0 = \left(1 - \frac{B}{A} \cdot \frac{\lambda_1}{\lambda_1 - \lambda_2}\right) e^{-\lambda_1 t} + \frac{B}{A} \cdot \frac{\lambda_1}{\lambda_1 - \lambda_2} \cdot e^{-\lambda_2 t},$$

which is of the form of the empirical equation given above if the coefficients are both positive. Hence λ_1 is greater than λ_2; in the experiments with polished zinc $\lambda_1 = 0{\cdot}1865$, $\lambda_2 = 0{\cdot}0104$, or the time for (A) to fall to half-value is 5 min. and for (B) 67 min., values which are not much affected by polish and intensity of the light. In some cases the rapid fatigue is followed by a gradual recovery which arises from the longer waves. This may be due to the rise in temperature they cause. The question whether fatigue takes place in a vacuum has been answered differently by different observers; in the present case the fatigue under such conditions is unmistakable. R. S. W.

705. *Alternate-current Phasemeter.* **F. Lori.** (N. Cimento, 12. pp. 348–354, Nov. and Dec., 1906. From Real Istit. Veneto, Atti, Vol. 65. Electrical World, 49. p. 716, April 6, 1907. Abstract. Electrician, 58. p. 809, March 8, 1907. Abstract.)—This phasemeter is an improvement upon the instrument described in 1905, which required a synchronous motor. The part vibrating in electromechanical resonance is a small coil R 25 mm. in diam. mounted between ebonite plates. This coil is attached to a spring M fixed at P, and bearing a needle N on the other side, which slides over an ebonite cylinder C, one of whose generating circles is a metallic plate 0·1 mm. thick. The small coil is mounted between two electromagnets fed by the alternating current under investigation. The needle moves to and fro under the alternating magnetic field. The amplitude of the excursion may attain 1 cm., and a displacement of one-third of a degree of arc may be made to annul the metallic contact. Differences of phase are measured by using two such coils. The instrument is both sensitive and constant. E. E. F.



706. *Standard Cells.* **K. E. Guthe** and **C. L. v. Ende.** (Phys. Rev. 24. pp. 214–221, Feb., 1907.)—During the past winter a number of Clark and cadmium cells stood for some weeks in diffused light and were exposed for a few days to large temperature variations. A comparison of the cells after this time showed that the e.m.f. of the cadmium cells had decreased relatively to that of the Clark cells. It appears that in the interval Sept., 1905,–Jan., 1907, the e.m.f. of 6 cadmium cells containing electrolytic mercurous sulphate decreased by amounts varying from 0·42 to 0·07 millivolts, the mean diminu-

tion being 0·17 millivolt. In the same time 2 cadmium cells set up with chemically-prepared mercurous sulphate diminished by 0·15 and 0·11 millivolt respectively. To decide whether a change had taken place in the Clark cells chosen as reference standards, fresh cells were prepared. The new Clark cells agreed within 0·08 millivolt with the old ones, except when the mercurous sulphate was prepared electrolytically and washed with alcohol; a lowering of the e.m.f. by over 0·40 millivolt then resulted, without an appreciable change in course of time. New cadmium cells differed appreciably from old ones, and after 2 months the difference between certain of the new cells was 0·27 millivolt. Hulett suggested that such changes are due to the system in the kathode leg being not in equilibrium, and recommended a considerable depth of paste. The same rapid decrease in e.m.f. was observed in cells in which the paste was over 2 cm. deep. [See also Abstracts Nos. 2311 (1904), 1432, and 1904 (1906). F. E. S.

ALTERNATING CURRENTS AND MAGNETISM.

707. *Ultramicroscopic Study of Alternating Currents.* **A. Terenzio.** (Elettricista, Rome, 6. p. 21, Jan. 15, 1907.)—The method devised by Cotton and Mouton [Abstract No. 1379 (1904)] may be made practically available by a suitable choice of the rate of oscillation of the microscope stage. Granules of colloid substances in suitable solvents show as bright points on a dark field in the ultra-microscope. These granules faithfully follow every change in the electric field, oscillating to and fro when the field is an alternating one. On displacing the stage at right angles to these visible oscillations, the latter are drawn out into a wavy curve. The evanescence of this curve may be obviated, according to the author, by giving the stage an oscillating motion whose period is equal to that of the current, or a submultiple of it. When this is exactly brought about the curve is steady and permanent, since the curve traced on returning is the image of that traced on going. A pure sine curve may be obtained under favourable conditions by making the motion of the stage uniform, but this is not essential. The motion may be brought about by an auxiliary motor driven through suitable gearing by the current under investigation. E. E. F.

708. *Harmonic Analysis of Alternating-current Waves.* **L. A. Hazeltine.** (Elect. Rev., N.Y. 50. pp. 285–286, Feb. 9, 1907. Reprinted from "The Stevens Institute Indicator.")—The method given by the author is as follows. The wave to be analysed being plotted in a rectangular co-ordinate diagram, whose abscissæ represent angles in radians, a polar diagram is plotted for determining each harmonic. If the harmonic required is the *n*th, which may be represented by $A_n \sin nx + B_n \cos nx$, the vectorial angle in the polar diagram is made equal to nx (where x is the abscissa in the original wave) and the radius vector is made equal to the ordinate of the original wave. The polar curve will become re-entrant after $n/2$ revolutions. From this polar curve two new rectangular co-ordinate curves are plotted, each having for its abscissæ those of the original wave, while for ordinates one of them has the abscissæ, and the other the ordinates, of the polar curve. The mean ordinates of the two curves so constructed correspond to $\frac{1}{2}B_n$ and $\frac{1}{2}A_n$, and from them the amplitude and phase of the *n*th harmonic are immediately obtainable. The advantage of the method is its simplicity and rapidity, and the fact that the analysis for each harmonic is independent of that for the others, so that there is no accumulation of errors. A. H.

709. *Theory of the Telephone Receiver.* **H. Poincaré.** (Écl. Électr. 50. pp. 221–234, Feb. 16; 257–262, Feb. 23; 329–338, March 9; 365–372, March 16, and pp. 401–404, March 23, 1907.)—Let x be the displacement of the centre of the membrane from its equilibrium position, $x'(=dx/dt)$ its velocity, and i the current in the coil. Then by considering the mechanical forces, we get by Lagrange's equation—

$$mx'' - M'i + kx = \Phi - Fx' \quad\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots(1).$$

In this equation m denotes a certain fraction of the mass of the membrane, M′ the attraction exerted on the plate by the coil when the current i flows in it, k depends on the forces acting on the plate when there is no current on the coil, forces due, for instance, to the remanent magnetism and the way the plate is fastened at its edges. Φ is the moving force acting on the plate; it is zero for a receiver, and is the pressure of the air for a transmitter. Fx' denotes the damping forces which are proportional to the velocity. Applying Lagrange's equation to the electric system, we get—

$$M'x' + Li' + Ri = E \quad\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots(2),$$

where L is the self-inductance of the coil, R its resistance, and E represents the e.m.f. applied at the terminals of the receiver. Assuming that x and i are functions of the form $\epsilon^{\omega t}$, we get—

$$x(m\omega^2 + F\omega + k) - M'i = 0\ ;\ M'\omega x + (L\omega + R)i = 0,$$

when E and Φ are zero. Hence ω must satisfy the equation—

$$(m\omega^2 + F\omega + k)(L\omega + R) + M'^2\omega = 0 \quad\ldots\ldots\ldots\ldots\ldots\ldots(3).$$

In order that the movement be stable it is necessary that the real part of the imaginary roots of this equation be negative, and that the real root or roots of this equation be also negative. As the coefficient mL of ω^3 is positive, and as the one or three real roots must be negative, kR must be positive, and therefore k must be positive. Hence the coefficients of all the terms are positive, and the roots are either real and negative or one real negative root and two imaginary roots, of which the real parts are negative. It is proved that when we have two identical receivers (Bell instruments, for instance) connected by short wires of negligible inductance and resistance, the free periods are the same as for each considered separately, the resulting equation being identical with (3). The case of a telephone and microphone is next considered fully, the resulting equation to determine the free vibrations being a biquadratic. It is again found that when k is positive the roots, if real, are negative, and if imaginary their real parts are negative. The curious and important result is proved that two of the roots are always real. Hence there is only one free period. The following data for an Ader telephone are given. Receiver: Resistance of coil measured, by direct current 140 ohms, by alternating current ($f=1000$) 272 ohms; self-inductance, 24 millihenrys. Primary coil of microphone (secondary open): Resistance by direct current 1·5 ohms, by alternating current ($f=1000$), 13 ohms; self-inductance, 8 millihenrys. Secondary coil of microphone (primary open): Resistance by direct current 154 ohms, by alternating current ($f=1000$) 430 ohms; self-inductance, 400 millihenrys. Secondary coil of microphone (primary closed through 10 ohms): Resistance by alternating current ($f=1000$) 670 ohms; self-inductance, 36 millihenrys. It is to be noticed that the resistance of an Ader receiver varies from 140 to 272 ohms as the frequency increases from 0 to 1,000. This is due to the watts lost by eddy currents in the core. It is also seen that both the resistance and inductance vary with the resistance connected across the secondary. These variations are due to the mutual inductance between the primary and secondary. It is proved that the effective mass *m* of the vibrating plate may be taken equal to one-fifth its whole mass. Abraham's method of determining *k* and M′ is also given. Assuming that the electromagnet is circular, the eddy currents in the core are calculated, the results being given in terms of Bessel's functions of complex arguments. (In A. Russell's *Alternating Currents*, vol. 1. p. 871, they are given in terms of *bei* and *ber* functions.) The author next obtains the solution for a core of rectangular section, and, when the currents at an appreciable depth are negligible, an approximate solution is obtained for a core the cross-section of which has any shape. It is also shown how the effects of the eddy currents on the values of L and R can be calculated. The difficult problem of calculating the eddy currents in the vibrating plate is next solved, and it is shown that they have an appreciable effect on the working of the instrument. A mathematical method of taking hysteresis into account is developed, and it is shown that the effect of hysteresis is to introduce harmonics into the simple tones. The effects, however, are negligible when compared with the effects of eddy currents. The author finally shows how the influence of the line constants can be taken into account, and hence very approximate solutions of the most complicated practical cases can be obtained by his methods. A. R.

710. *Magnetisation, Field and Torsion.* **H. Bouasse** and **Berthier.** (Annal. Chim. Phys. 10. pp. 199–228, Feb., 1907.)—The already great amount of research on this subject has dealt with the relation of only two of these variables at one time. But by making changes in one of the variables, while of the two other factors one is definitely known and constant and the other is a variable dependent on the first, the authors have obtained several new relations and some new forms of hysteresis curve. Thus the B-H curve for iron is obtained either when torsion is constant on the wire used, or when a regular torsion (+ H —) cycle is made for each value of H before B is measured. Another curve is obtained by magnetising the wire by a strong field, ascertaining the magnetisation; then applying +torsion, and again finding the magnetisation; then applying —torsion, and so on. Each new torque reduces the magnetisation. Another relation is obtained after the wire has been drawn out 3 per cent., 5 per cent., or 10 per cent., without using a draw-plate. Throughout the experiments tension and temperature are constant. The latter variables could be employed in other like experiments; but two independent and one dependent variables seem as many as can be dealt with at one time. P. E. S.

711. *Nature of Permanent Magnets.* **R. Gans.** (Ann. d. Physik, 22. 3. pp. 481–504, March 5, 1907. Phys. Inst., Tübingen, Dec. 17, 1906.)—The author champions the view that "free magnetism" has a real existence, and that consequently the surface integral of μH over a closed surface does not necessarily vanish in the case of permanent magnets. Experiments were carried out by the author for the purpose of determining the differential permeability and the ordinary permeability of a permanent magnet as functions of the field intensity. The induction in an elongated ellipsoid of revolution was measured by the magnetometric method, and at the same time the differential permeability by a ballistic method, a small auxiliary field

being used for the purpose. From the differential permeability the ordinary permeability μ was determined. The author finds that the μ deduced in this way has a constant value, and hence that, according to Kempken's results [Abstract No. 1920 (1906)], the induction B may, in the case of permanent magnets, be written in the form $B = \mu H + M$, where both μ and M are constants. The value of μ found in the case of a permanent magnet agrees with that measured in steel temporarily magnetised, provided μ is calculated from the differential permeability, and not determined by a current reversal.

A. H.

712. *Non-homogeneous Magnetic Field.* **F. Bidlingmaier.** (Phys. Zeitschr. 8. pp. 176–179, March 15, 1907.)—This paper gives a description, with the mathematical theory, of a method for the investigation of the non-homogeneity of a magnetic field. A system of two magnets, free to swing independently in horizontal planes, and the centre of one being vertically above the centre of the other, is suspended by a fine fibre. In any particular case each magnet is capable of taking up two positions, according as the one or the other is turned towards the east or west; the angular difference between these two positions reveals the non-homogeneity of the field. Let ψ_1 be the total angle between the two magnets in one case, and ψ_2 the total angle after the change in position; χ the angle between the two positions of the upper magnet, and χ' the angle between the two positions of the lower magnet; then it is shown in the paper that (1) the difference between the total angles gives the difference (δ) between the direction of the lines of force at the places where the upper and lower magnets are—

$$\delta = \tfrac{1}{2}(\psi_1 - \psi_2) \tan^2 \tfrac{1}{2}(\psi_1 + \psi_2).$$

To get the best results ψ must be as small as possible. (2) The difference between the angles χ and χ' gives the difference in the horizonal intensity at the places of the upper and lower magnets. If h is the difference between the horizontal intensity (H) at the lower and that at the upper magnet, M and M′ being the magnetic moments of the upper and lower magnets respectively, then—

$$-\frac{h}{H} = \frac{\tfrac{1}{2}(\chi - \chi')}{\tan \tfrac{1}{2}(\psi_1 + \psi_2)} + 2\frac{M - M'}{M + M'}.$$

So for this case ψ must be as large as possible. The method is nearly independent of variations in the earth's magnetic field and of all other disturbances, since these affect the upper and lower magnets in an equal degree.

A. W.

713. *Magnetic Storm and Aurora, Feb.* 9–10, 1907. **C. Chree.** (Nature, 75. p. 367, Feb. 14, 1907.)—The magnetic storm which was recorded at the Kew Observatory on the afternoon of Feb. 9 and early morning of Feb. 10 was larger than any since Oct. 31, 1903. The curves were slightly disturbed during the whole of Feb. 9, but the storm may be regarded as commencing with a rapid movement of a few minutes of arc in the declination needle at 2.15 p.m. with a synchronous sudden rise of 45 γ in the horizontal force. The storm lasted an unusually short time, being practically over by 3 a.m. on Feb. 10. The largest declination movement occurred between 8.19 p.m. and 8.45 p.m. on Feb. 9; during these 26 min. the needle moved 57′ to the west and then 78′ to the east. In the case of the horizontal force, the force fell more than 355 γ between 8.25 p.m. and 8.38 p.m. on Feb. 9, when it went off the sheet for a few min. Between 8.40 p.m. and 8.49 p.m. it increased fully 240 γ. The total range during the storm exceeded 480 γ. The vertical force, though less disturbed than the other elements, showed a range of 825 γ. The storm was doubtless associated with the aurora which was widely observed on the evening of Feb. 9. C. P. B.

714. *Magnetic and Electric Hysteresis.* **E. Madelung.** (Phys. Zeitschr. 8. pp. 72–75, Feb. 1, 1907. Inst. f. angew. Elektrizität, Göttingen, July, 1906. Écl. Électr. 50. pp. 883–884, March 16, 1907. Electrical World, 49. pp. 715–716, April 6, 1907. Abstract.)—Describes some new connections for Braun tubes, by means of which magnetic and dielectric hysteresis may be studied. If the points of the ordinary hysteresis loops are rounded, it means that there is a difference of phase between field and magnetisation. This rounding is imperfectly seen in Ångström's arrangement of the Braun tube [Abstract No. 2102 (1905)], but if the co-ordinates represent dI/dt and dH/dt instead of I and H, the rounding of the points is replaced by the failure of the curve to pass twice through the origin. An arrangement for fulfilling these conditions is shown in the diagram (Fig. 1), where the current traverses two coils in succession, one of which contains the specimen of iron. Secondary circuits from these coils feed opposite pairs of electrodes surrounding the Braun tube BR. The arrangement for observing dielectric hysteresis is shown in Fig. 2. The author reproduces curves obtained with these two arrangements, which fulfil all expectations. E. E. F.

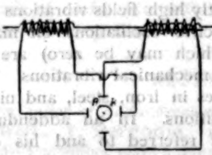


Fig 1

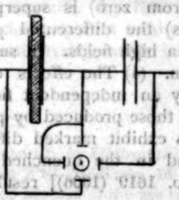


Fig 2

715. *Magnetisation by Alternating Currents of High Frequency.* **O. M. Corbino.** (Accad. Lincei, Atti, 16. pp. 167–170, Feb. 3, 1907.)—Battelli and Magri have come to the conclusion that there is an increase in area of the hysteresis loop at high frequencies whenever the eddy currents become of importance, and that when these are eliminated there is a slight decrease in area. [See Abstract No. 116 (1907)]. The author points out that he obtained an increase of hysteresis [loss] with frequency [see Abstract No. 2781 (1904) even under such conditions that according to Battelli and Magri the eddy currents should be negligible. He concludes that the difference in behaviour in the two sets of experiments is due to the varying quality of the material employed. The increase in area in his experiments with soft iron is not due to eddy currents, and the constancy and even diminution in Battelli and Magri's results is probably due to the hardness of the steel employed.

S. G. S.

716. *Superposition of Mechanical Vibrations (Electric Oscillations) upon Magnetisation, and Conversely.* **J. Russell.** (Roy. Soc. Edinburgh, Trans. 45. 17. pp. 491–517, 1907.)—The author has examined the effect of mechanical

vibrations (obtained from an electric bell gong) on wires of mild steel, iron (not soft), and nickel in the annealed and the quenched states, using a ballistic method. The experiments were made under the A- and B-conditions defined by the author [Abstract No. 1119 (1906)], the intensity of the vibrations being varied in one set of observations and kept constant in another. The results are separately given under the headings: Permeability; Residual magnetisation in relation (*a*) to field, (*b*) to induction; Coercive force; Hysteresis loss in relation (*a*) to field, (*b*) to induction. Those results which are common to all three metals (without reference to load) are summarised by the author briefly as follows: (1) In all cases vibrations increase permeability (induction), but in high fields the ratio B_v/B is nearly unity, where B is the induction without, and B_v with vibrations. (2) The effect of vibrations superposed at all stages of the normal loop (A-conditions) is, in general, to lessen those differences of magnetisation to which hysteresis *without vibrations has already given rise.* (3) When change of field (cyclic or increasing from zero) is superposed on permanently acting vibrations (B-conditions) the differential permeability is increased in low fields, diminished in high fields. In sufficiently high fields vibrations must delay magnetisation. (4) The effects of electric oscillations on magnetisation supported by an independent field (which may be zero) are essentially the same as those produced by purely mechanical vibrations. The effects of vibrations exhibit marked differences in iron, steel, and nickel in the annealed and in the quenched conditions. In an addendum, Eccles' [Abstract No. 1619 (1906)] results are referred to and his conclusions criticised. L. H. W.

ELECTRO-PHYSIOLOGY AND ELECTRO-THERAPEUTICS.

717. *Röntgen-ray Intensity Measurements.* **Blythswood** and **W. A. Scoble.** (Röntgen Soc., Journ. 3. pp. 58–62; Discussion, pp. 62–67, Feb., 1907.)—A description of researches on the relation between the measurements from a focus tube, with a view to determine which are proportional to the intensity of the Röntgen rays. From the results obtained it appears that readings of the current through and potential across the focus tube do not give satisfactory measurements of the intensity of the emitted rays. Of the photographic methods, Kienböck's is the most accurate [see Abstract No. 495 (1907)], but it has the objection that the treatment must be suspended for the development and comparison with a scale of the photographic strip. On plotting the leakage current against the intensity of the rays, the points for all the tests lie around a straight line joined to a curve, and hence the authors conclude that the leakage current may give definite measurement of the intensity. The curves connecting the leakage current and the thickness of aluminium through which the rays have passed are smooth and seem to confirm the ionisation method as a means of measuring the intensity. In the *discussion*, **J. H. Gardiner** pointed out several objections to the ionisation method. A. W.

718. *New Application of Röntgen Rays.* **F. Dessauer.** (Deutsch. Phys. Gesell., Verh. 9. 3. pp. 49–60, Feb. 15, 1907. From the Vereinigte Elektrotechn. Instituten Frankfurt-Aschaffenburg.)—After pointing out the inherent drawbacks connected with the usual method of exposure to Röntgen rays, so far as therapeutic effects are concerned, the author describes his own method, which consists in placing the source of the rays at a distance so great that the depth of the tissues to be penetrated is negligible in com-

parison, and hence the rays may be considered as suffering a *homogeneous* absorption in their passing through the body. The arrangement adopted is to employ two or more Röntgen-ray tubes suspended close to the ceiling in a room of, say, 20 sq. m. area and 4–5 m. high. The tubes employed are very hard ones and emit rays of great penetrating power. A fluorescent screen placed either on the floor or 1 m. above it fluoresces with equal brightness, and Holzknecht's chromo-radiometric buttons also are coloured equally in two situations, thus indicating that in such a position the radiation can be taken as being probably homogeneous for a penetration into the tissues of some cm. Since the exposure with this method must be very protracted, the special means by which the life of the tubes may be prolonged are considered. The best arrangement is found to consist in the employment of alternating current, transformed up to a high voltage, both half-waves being used, by means of separate and independent Röntgen-ray tubes. Each tube receives rectified impulses as a result of the inclusion of valve-tubes in the circuit, which control the passage of the currents. By this means tubes have been run continuously for 8–10 hours daily, up to a total of 250 hours, while the limit of useful life with the usual arrangements is only about 40 hours actual running time. L. H. W.

REFERENCES.

719. *Determination of Radiochromometric Intensity by Electrostatic Voltmeter in Röntgen-ray Work.* **J. Bergonié.** (Archives d'Él. Médicale, 15. pp. 123–135, Feb. 25, 1907.)—The author gives a more detailed account of the use of the electrostatic voltmeter as a guide to the radiochromometric intensity of the rays employed [see Abstract No. 315 (1907)]. When in any case different radiochromometric intensities are obtained with the same apparent watts supplied to the tube, other conditions being the same, the author points out that the production of heat at the antikathode is much greater with soft than with hard rays; and this effect can be attributed either to the power-factor or to the fact that the output-coefficient of the tube may have different values with hard rays than with soft ones. L. H. W.

720. *Theory of Thermo-electricity.* **S. Sano.** (Physico-Mathematical Soc., Tokyo, Proc. 4. 1. pp. 2–26, Feb., 1907.)—This theory is based on Boltzmann's, but is mathematically too intricate for abstract. R. E. B.

721. *Electric Conductivity of Salt Vapours.* **G. C. Schmidt** and **W. Hechler.** (Deutsch. Phys. Gesell., Verh. 9. 2. pp. 39–48, Jan. 30, 1907. Phys. Inst. d. Univ., Königsberg, Dec., 1906.)—The conductivity of the vapours of various salts is tested. Organic vapours and the halogen salts of mercury show no appreciable conduction, the halogen salts of Zn and Cd, NH_4I and NH_4Br show great conducting power. The measurements on CdI_2 appear to show that Ohm's law is obeyed. [Most of the facts have previously been observed, see Abstract No. 388 (1905).] R. S. W.

722. *Dynamo for Continuous Current.* **L. Trafelli.** (Elettricista, Rome, 5. pp. 305–307, Nov. 15, 1906.)—Description of dynamo on the lines of the Faraday-Barlow disc, in which Foucault currents, &c., are eliminated by making the lines of force run right across the armature from one face to the other. A model is described suitable for 110 volts, and for being driven directly by a turbine. A. D.

723. *Zimmern's Spiro-Conductor.* (Archives d'Él. Médicale, 15. pp. 142–143, Feb. 25, 1907.)—An application of the metallic spring tapes commonly used, the tape being in this case of copper or brass (silk-covered) and the metal case fastened to one terminal, enough tape being then drawn out to enable its end to make the desired connection. L. H. W.

CHEMICAL PHYSICS AND ELECTRO-CHEMISTRY.

724. *Molecular Weights of Gases calculated from their Limiting Densities.* **D. Berthelot.** (Comptes Rendus, 144. pp. 269–272, Feb. 4, 1907.)—The value of $1 - pv/p_0v_0$ for a gas is generally taken to be approximately representable by either ϵ/v or αp; these are, however, not equivalent, and the former is very much the more exact, so that it should be used in estimating the limiting densities. The molecular weight of oxygen being taken as 32, the means of the values of the molecular weights of other gases deduced from the observations of different experimenters are: Hydrogen 2·015, nitrogen 28·015, NH_3 17·021, N_2O 43·999, NO 30·002, CO 28·005, CO_2 44·007, HCl 36·474, SO_2 64·057, chlorine 35·466, sulphur 32·057. (*Errata*, ibid. p. 352, Feb. 11.)

R. E. B.

725. *Calcium as an Absorbent of Gases for the Production of High Vacua and Spectroscopic Research.* **F. Soddy.** (Roy. Soc., Proc. Ser. A. 78. pp. 429–458, Feb. 2, 1907. Chem. News, 94. p. 305, with Addendum by **A. J. Berry**, Dec. 28, 1906; 95. pp. 13–15, Jan. 11; 25–28, Jan. 18; 42–45, Jan. 25, and p. 51, Feb. 1, 1907. Abstract.)—An account of some researches into the use of metallic calcium as an absorbent for gases. An electrical method is employed for heating the calcium, two types of apparatus being described. In the first the calcium is placed in a porcelain test-tube, which is heated by a coil of platinum wire carrying a current. The whole is mounted in a glass tube, which is protected by a porcelain shield tube from the heat of the furnace. In the second type an induction method is used. A bundle of iron wires, similar to the core of an induction coil, is put through a ring turned out of a bar of calcium, and the whole is placed in an exhausted glass tube, the walls of which are protected from fusion by a porcelain shield tube as before. A bobbin of insulated wire traversed by an alternating current of high periodicity, is slipped over the glass tube, when the calcium may be readily heated to its absorption temperature. When the calicum is first heated *in vacuo* gaseous compounds of carbon, hydrogen, and oxygen are given off; if the heating be continued absorption of the gases begins, accompanied by volatilisation of the calcium. Experiments were made on the power of calcium to absorb different gases, with a view of using the method in exhausting vacuum tubes for spectroscopic research, and it was found that it is a universal absorber for all chemically valent gases; that is to say, all gases except the argon group are rapidly absorbed, with the result that a non-conducting vacuum is readily obtained. Sections of the paper are devoted to the application of this method to the determination of the quantities of pure helium and argon respectively which are detectable by the spectroscope, and the author shows that a far larger quantity in each case than has previously been supposed is necessary. When helium is mixed with a very small quantity of a diatomic gas it is possible to detect extraordinarily minute amounts. Using a vacuum tube of 0·3 c.cm. volume it is possible to detect 1/4000000 part of 1 c.cm. In an appendix **A. J. Berry** publishes some comparative measurements of vacua produced by three different methods, namely, exhaustion by a mercury pump, exhaustion by Dewar's method with charcoal, and by the Dewar method after a previous exhaustion by a Fleuss pump. A Dewar liquid-air flask was exhausted by each method in turn, and the evaporation of some liquid air put into the flask was observed in each case. It was found that by far the best results were obtained by the last method. E. C. C. B.

726. *Physical Properties of Liquid Nitrogen.* **H. Erdmann.** (Ber. Deut. Chem. Gesell. 39. pp. 1207–1211, 1906.)—Liquid nitrogen, which is colourless, differs markedly in its physical properties from liquid air; it is a good solvent for liquids boiling at a low temperature. In liquid nitrogen both ice and absolute alcohol sink so soon as the first evolution of gas has ceased. This is considered to support Ramsay and Drugman's value for the sp. gr. (0·7914 at boiling-point) as against Dewar's (0·850). The temperature produced by the evaporation of liquid nitrogen is lower than that produced by liquid air. The miscibility of liquid nitrogen with liquid ozone is very marked. L. H. W.

727. *Preparation of Fused Molybdenum.* **H. Biltz** and **R. Gärtner.** (Ber. Deut. Chem. Gesell. 39. pp. 3370–3371, 1906.)—The yield of molybdenum by the aluminothermic method is considerably increased by substituting the dioxide for the trioxide, 52 gm. of melted molybdenum of 98·5 per cent. being obtained by firing 80 gm. MoO_2 with 21 gm. Al powder. The dioxide is readily prepared by reducing the trioxide at a red heat in a stream of hydrogen. W. H. Si.

728. *Chromium Boride.* **E. Wedekind** and **K. Fetzer.** (Ber. Deut. Chem. Gesell. 40. pp. 297–301, 1907. Chem. News, 95. p. 107, March 1, 1907. Abstract.)—Chromium boride may be prepared by allowing the liquefied metal formed from chromium thermite to act on the calculated amount of boron. Amorphous boron is placed at the bottom of a Hessian crucible, and covered first with chromium thermite, then with a thick liquid produced by treating the latter with liquid air, a mixture of barium peroxide and aluminium being added to the top layer. The resulting product is extracted successively with dilute HCl, HNO_3, and aqua regia, washed with water, and dried, when a silver-white crystalline powder is obtained, corresponding to the formula CrB, and having a density at 17° C. of 5·4. It is very hard, easily scratching glass and quartz, is an electrical conductor, and ferromagnetic. W. H. Si.

729. *Silicides of Zirconium and Titanium.* **O. Hönigschmid.** (Akad. Wiss. Wien, Sitz. Ber. 115. 2b. pp. 871–883, July, 1906. From the chem. Laborat. d. k.k. deutsch. Univ., Prag.)—The methods mentioned for the preparation of $ZrSi_2$ and $TiSi_2$ are (*a*) the reduction of the double fluorides of Zr or Ti with potassium, and potassium fluosilicate with aluminium, at about 1,200°. $ZrSi_2$ thus prepared occurs in rhombic prisms, $TiSi_2$ as tetragonal pyramids. (*b*) [See Abstract No. 1800 (1906).] If a mixture of zirconium potassium fluoride with Al be heated for some time at 1,200°, crystals of $ZrAl_3$ are obtained having the form of square plates. F. R.

730. *Nitrogen-Lime.* I. **G. Bredig** [in conjunction with **W. Fraenkel** and **E. Wilke**]. (Zeitschr. Elektrochem. 13. pp. 69–75, March 1, 1907. Chem. Universitätslaborat., Heidelberg, Jan., 1907.)—The fixation of nitrogen to cyanide and calcium cyanamide is little understood, and opinions differ concerning the observation of Polzeniuss [D.R.-P. 163,320; see Abstract No. 1089B (1906)], that the fixation of nitrogen by calcium carbide is much accelerated in the presence of the chlorides of the alkalies and alkaline earths. The authors conduct the experiments so far as possible at constant temperatures by spreading the carbide in thin layers, so as to avoid the influence of the alleged initial ignition. About 80 gm. of commercial calcium carbide and 8 gm. of another substance placed in a little boat are heated in a Heraeus furnace, a thermocouple enclosed by an iron tube being embedded longitudinally in the mass, over which Linde's nitrogen is passed. At 800° C. the following results were observed: Carbide alone, poor yield and slow reaction; addition of $CaCl_2$, very high velocity of reaction, good yield; NaCl (also KCl, LiCl), reaction accelerated for a period, not permanently; CaF_2, CaO, MgO, no distinct effect; sugar carbon, accelerated reaction; powdered coke, sea sand, no effect. Experiments at 700° C. gave similar results, except that LiCl proved most powerful, and sugar carbon had little effect. The experiments showed that a mere loosening of the mass (magnesia, sand) is useless; that oxide-forming salts (CaO) are not much concerned; and that the carbide does not, in the presence of chlorides, burn almost explosively in nitrogen. The influence of water vapour and other features are further to be studied; the commercial carbide applied always contained water and lime.

H. B.

731. *Isolation of Argon from the Air by the Aid of Calcium Carbide.* **F. Fischer.** [Experiments by **E. B. Maxted** and **G. Iliovici.**] (Zeitschr. Elektrochem. 13. pp. 107–108, March 22, 1907. Preliminary Communication from the chem. Inst. d. Univ., Berlin.)—The publication of Bredig's researches [see preceding Abstract] induce the author to declare that he has, in conjunction with E. B. Maxted and G. Iliovici, been preparing argon with the aid of CaC_2, and that they have also observed the influence of additions to the carbide. Calcium carbide mixed with 10 per cent. of calcium chloride is heated in electric furnaces of Heraeus or in gas furnaces, first in a vacuum, where acetylene and other gases and some tar are produced, and then in a current of dry air. Oxygen and nitrogen are absorbed under formation of lime, cyanamide, and carbon, and argon and the other new gases are isolated.

H. B.

732. *Formation of Nitrogen-Lime.* **F. Foerster** and **H. Jacoby.** (Zeitschr. Elektrochem. 13. pp. 101–107, March 22, 1907. From the Laborat. f. Elektrochemie u. physikal. Chemie d. techn. Hochschule, Dresden.)—According to Moissan pure CaC_2 does not bind nitrogen even at 1,200° C.; commercial calcium carbide does so, according to Frank and Caro, because it always contains lime. Polzeniuss (Gesellschaft für Stickstoffdünger) raises the yield in nitrogen-lime by adding calcium chloride to the carbide. F. Carlson recommends an addition of calcium fluoride; O. Kühling coal and the carbonates of Ca, Ba, Sr. The authors heat, like Bredig [see Abstract No. 730 (1907)], charges of 8 gm. of commercial carbide (of 84·6 per cent. of CaC_2) each in two porcelain boats, in a Heraeus electric furnace, alone or with additions. The heating of the impure carbide may cause explosion, as acetylene is generated according to $CaC_2 + Ca(OH)_2 \longrightarrow 2CaO + C_2H_2$. They confirm previous observations on the whole. With ordinary (impure) carbide the formation of nitrogen-lime soon ceases. An addition of $CaCl_2$ lowers the temperature of reaction to 700° and 800°; CaF_2 is not quite so useful, and acts more at lower percentages. It would appear that the additions lower the melting-point of the surface layer of carbide so that nitrogen can gain access to the interior. When the gas pressure in the tubular furnace, as a rule 132 mm. of water, was raised to 1,840 mm., the percentage of bound nitrogen rose slightly, from 17·6 to 19·9.

H. B.

733. *Synthetical Formation of Cyanogen and its Decomposition.* **Berthelot.** (Comptes Rendus, **144.** pp. 354–357, Feb. 18, 1907.)—Pure carbon, free from hydrogen and from the metals of the alkalies and the alkaline earths, does not combine with nitrogen ; the cyanogen produced by the voltaic arc is due to the presence of hydrogen, water vapour, and other impurities in the carbon electrodes. When pure acetylene gas is decomposed by electric sparks, a state of equilibrium is reached ; this is not so in the case of the decomposition of cyanogen. 77 cm.^{3} of cyanogen gave after several hours sparking a deposit of carbon or carbon compounds and 56 cm.^{3} of free nitrogen ; on continuing the sparking in another vessel, a little more carbon was deposited, and nothing but free nitrogen remained. There should be no contraction of volume, but polymerised carbon compounds are formed. All the cyanogen is decomposed, however, and there is no stable equilibrium between nitrogen and solid or gaseous carbon. Nor can the laws of thermodynamics be applied to explosions of gases and to instantaneous decompositions by electric sparks, because there is no uniform temperature distribution. H. B.

734. *Strontium Amalgams.* **A. Guntz** and **G. Roederer.** (Bull. Soc. Chim. 35. pp. 494–503, 1906.)—Crystals of an amalgam $SrHg_{11}$ have been obtained in large quantity by electrolysing a saturated solution of $SrCl_2$, using mercury at the kathode and a current of 1–1·5 amps. per cm.^{2} of kathode, at 20 volts, the temperature being maintained at 20–30° C. The crystals contain 8·8 per cent. of Sr, change rapidly in air, and are decomposed by water, but may be preserved in an atmosphere of dry CO_2. No mercury is lost at a pressure of 5,000 kg. per cm.^{2}, but on heating *in vacuo* mercury is given off and amalgams richer in strontium are obtained, in one experiment definite crystals containing 6·8 per cent. Sr, corresponding to the formula $SrHg_6$, being produced. Amalgams with 6–10 per cent. Sr are brittle, hard, and fine-grained, and not much affected by air. At 1,000° C. an amalgam containing about 50 per cent. Sr distils unchanged, so that pure strontium cannot be prepared by distillation of these alloys. W. H. Si.

735. *Iron and Calcium.* **O. P. Watts.** (Amer. Chem. Soc., Journ. 28. pp. 1152–1155, Sept., 1906.)—Attempts to make Fe–Ca alloys by (*a*) fusing mixtures of the two metals in a graphite crucible in an electric resistance furnace ; (*b*) heating Ca in a pure iron cylinder at 850–880° ; and (*c*) reducing iron oxide with excess of Ca in the form of filings, failed. In case (*a*) the Fe gained C and Si, probably from the crucible. By heating iron with Ca its S and P contents may be reduced, but the process is not thought to be applicable commercially. In one case an iron was entirely freed from S, and in another P was reduced from 1·96 to 1·56 per cent. F. R.

736. *Alloys of Palladium with Silver.* **R. Ruer.** (Zeitschr. Anorg. Chem. 51. 3. pp. 315–319, Dec. 3, 1906. Inst. f. anorgan. Chemie d. Univ., Göttingen, Sept., 1906.)—The melting-point curve of mixtures of palladium and silver is concave to the axis of concentration, indicating that the metals form no chemical compounds but a continuous series of mixed crystals ; this conclusion is supported by the homogeneous appearance of the crystal sections and their behaviour when etched with dilute acid. T. H. P.

737. *Alloys of Palladium with Gold.* **R. Ruer.** (Zeitschr. Anorg. Chem. 51. 3. pp. 391–396, Dec. 3, 1906. Inst. f. anorgan. Chemie d. Univ., Göttingen, Oct., 1906.)—Palladium and gold form a continuous series of mixed crystals, and the melting-point curve, which is concave to the axis of concentration, gives no indication of chemical combination. The Pd-Ag cooling curve [see preceding Abstract] lies intermediate in curvature between those of Pd-Au and Pd-Cu [Abstract No. 515 (1907)]. Palladium-gold alloys containing more than 10 per cent. Pd are practically white, and their hardness increases from that of gold (2·5) to about 3·5 for a content of 70 per cent. Pd and afterwards diminishes to about 3, the value for palladium. The fact that neither copper, silver, nor gold combines with palladium is in agreement with Tammann's rule [Abstract No. 1627 (1906)] that either all, or none, of the elements of a natural group form compounds with any one particular element. T. H. P.

738. *Alloys of Lead with Thallium and Indium.* **N. S. Kurnakow** and **N. A. Puschin.** (Jurn. Russk. Fisik.-Chimičesk. Obščestva, 38. pp. 1146–1167, 1906. Zeitschr. Anorg. Chem. 52. 4. pp. 430–451, Feb. 22, 1907. Translation.)—Pb-Tl alloys with 0 to 6·5 atoms of Pb per cent. consist of the solid solution α, and with from 24·7 to 100 atoms of Pb per cent. of the solid solution β. The complete solidification diagram is given; the freezing-point curve consists of a sweep convex upwards, with a sharp change of direction at 6·5 atoms per cent. Pb, and a maximum at 380° with about 36 atoms per cent. Pb. This is shown to be a dystectic point. From the 227° change-point of pure Tl a line falls to 194° with 4·08 atoms per cent. Pb, corresponding to the separation of the α crystals. The microstructure of cast samples is correlated with the crystallisation of samples of Tl deposited from solution. Pb and In are shown to form an uninterrupted series of mixed crystals. Tl and In give a freezing-point curve of two branches meeting at 180° (44·5 atoms of Tl per cent.); from 0 to 44·5 it is convex downwards, and in this range In holds Tl in solid solution. The other portion of the curve is concave downwards; with from 56 to 100 atoms per cent. Tl, In is in solid solution in Tl. [See also Abstract No. 1149 (1902).] F. R.

739. *Zinc-Thallium and Zinc-Iron Alloys.* **A. v. Vegesack.** (Zeitschr. Anorg. Chem. 52. 1. pp. 30–40, Jan. 3, 1907. Metallog. Communication from the Inst. f. anorgan. Chemie d. Univ., Göttingen. Metallurgie, 4. pp. 53–54, Jan. 22, 1907.)—Thallium is soluble in zinc to an extent of about 2·5 per cent., but further addition of Th results in the formation of two distinct layers in the fused metals; when the composition reaches 95 per cent. Th the upper (Zn) layer disappears, about 5 per cent. of Zn being soluble in Th at the melting-point of the latter. The use of an iron stirrer in making these alloys appeared to lead to the formation of a new crystalline constituent, and as this constituent did not appear when glass stirring rods were used, the formation of iron-zinc alloys was suspected. The investigation of the iron-zinc alloys was complicated by the effect of the high vapour pressure of Zn, and in consequence the diagram given by the authors does not extend beyond 26 per cent. of Fe. Over this range of concentration, the diagram shows two series of solid solutions and two compounds, $FeZn_7$ and $FeZn_3$. The microstructure of the alloys is described and illustrated, and the authors consider that it confirms the conclusions drawn from the thermal data. W. Ros.

740. *Lead-Palladium Alloys.* **R. Ruer.** (Zeitschr. Anorg. Chem. 52. 4. pp. 345–357, Feb. 22, 1907. Inst. f. anorgan. Chemie d. Univ., Göttingen.)—Describes the thermal and microscopic analysis of these alloys, giving an

equilibrium diagram. Starting from the freezing-point of lead at 327° C., the "liquidus" curve falls first to the eutectic point corresponding to a concentration of about 5 per cent. Pd and a freezing temperature of about 263° C. The curve then rises to a faint maximum at 20 per cent. Pd, and then falls slightly to a point corresponding to about 25 per cent. Pd. The next maximum occurs at a temperature of about 1,220° C., and corresponds to a Pd content of about 60 per cent.; another minimum occurs at 65 per cent. Pd, and thence the curve rises to the freezing-point of Pd at 1,541° C. The diagram also shows six horizontal lines; three of these intersect the liquidus at minimum points and correspond to eutectics, while the author ascribes the other three to the formation of three distinct compounds, none of which can exist in the liquid state. The two compounds indicated by maxima on the liquidus are regarded by the author as represented by the formulæ $PdPb_2$ (454° C.) and Pd_3Pb (1,219° C.) respectively. The other three compounds decompose at the temperatures 495°, 596°, and 830° C. respectively, the decomposition products being a liquid and a different solid phase. The constitution of these bodies could not be ascertained with the same degree of certainty as that of compounds which melt without decomposition, but the author regards the formulæ of the first and last named as being probably PdPb and Pd_2Pb respectively, while the one which decomposes at 830° C. contains between 37·5 and 40·7 per cent. Pd. The paper is illustrated by twelve photomicrographs confirming the results of the thermal investigation. W. Ros.

741. *Improved Lead Alloys.* (U.S. Pats. 834,099 and 839,444. Metallurgie, 4. p. 156, March 8, 1907. Abstracts.)—The percentage compositions of two alloys patented by G. F. Allen are: (*a*) Pb 96·5 to 99·95, Ni 3·5 to 0·05; and (*b*) Pb 99·9 to 91·0, Cu 0·05 to 4·5, Ni 0·05 to 4·5. They are claimed to resist corrosion better, and to be more malleable than other lead alloys. F. R.

742. *Process for Manufacture of Alloys.* (Fr. Pat. 366,866.)—In F. Dannert's process one of the metals is melted, and a fused mixture of powdered glass and an oxide of the second metal is added to it; *e.g.*, it is stated that Cu-Pb alloys containing from 40 to 70 per cent. of Pb can be made by adding to molten copper a mixture of lead oxide and powdered glass after fusion together. F. R.

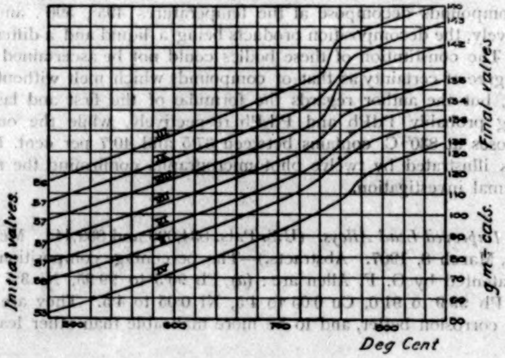
743. *Copper Alloy of Great Tensile Strength and Toughness.* (U.S. Pat. 820,954. Metallurgie, 3. p. 707, Oct. 22, 1906. Abstract.)—An alloy which is stated to have a higher tensile strength and extensibility than copper, brass, or bronze at high temperatures, is obtained, according to the process of G. Chandoir, Jr., by the addition of ¾ to 3½ per cent. of cadmium. The strength of copper at 500° C. is raised by this means to 30·3 kg./mm.^{2} (42,996 lbs. per sq. in.). Specially good results are obtained with an alloy of composition, Cu 92, Sn 4½, Cd 3½ per cent. L. H. W.

744. *Process for Toughening Iron and Steel.* (Mech. Eng. 19. p. 97, Jan. 19, 1907.)—In E. F. Colborn's process it is claimed that steel or iron quenched from a red heat in a solution containing 1/500 to 1/300 oz. of hippuric acid per gall., and various other ingredients, is rendered tougher and apparently fibrous, or more fibrous than before. Tool steel still retains its power of being hardened, and mild steel welds better after the treatment. It is said that the treatment is most effective if carried out under 50 to 100 lbs. per sq. in. pressure, and an apparatus for accomplishing this is described. F. R.

745. *Latent Heat of Recalescence in Steel.* **F. K. Bailey.** (Phys. Rev 24. pp. 129–151, Feb., 1907.)—The curves show the results of calorimetric determinations upon steels having the following percentage compositions :—

Steel	III.	IV.	V.	VI.	VII.	VIII.	IX.
Carbon	0·97	0·08	0·18	0·26	0·28	0·40	0·79
Manganese...	—	0·82	0·77	0·42	0·83	0·49	0·40

The ordinates are total cals. per gm. from the temperatures plotted as abscissæ to 20° C. The evolutions of heat at recalescence thus determined are given in the following table, with those determined by the heating and cooling curve method :—



Steel.	Latent Heat by Calori-meter, Gm.-cals.	Latent Heat from Heating and Cooling Curves.		Temperature of		Rise of Tem-perature at Recal-escence.
		Heating.	Cooling.	Absorption.	Evolution.	
IV........................	8·6	—	2·8	729°	669°	0
V........................	11·4	8·6	8·6	720	668	2°
VI........................	9·7	8·2	6·5	728	691	4
VII........................	9·7	7·8	8·5	727	661	10
VIII........................	16·0	10·9	18·0	733	705	8
IX........................	15·4	10·3	16·0	735	718	7
VIII. (after hardening)	—	—	18·2	729, 733	708, 698	9

Incidentally, support is found for the views that the specific heat is lower above the critical range than below it, and that the critical change does not occur completely at one temperature, however long the specimen be held at that temperature, but a definite proportion of the change only takes place.

F. R.

746. *Action of Iron Oxide with Zinc Blende.* **C. A. Graumann.** (Metallurgie, 4. pp. 69–77, Feb. 8, 1907. Communication from the Aachener Inst. f. Metallhüttenw. und Elektrometallurgie.)—It is found that in a nitrogen atmosphere there is a weak reaction between Fe_2O_3 and ZnS. The F_2O_3 is, however, quickly reduced in part to FeO, and the reaction then practically ceases. In a weakly oxidising atmosphere SO_2 and Zn are liberated. When the mixture is heated the reaction $ZnO + FeS \rightleftarrows ZnS + FeO$ tends to take place in the direction ZnS + FeO. The author proposes to replace the process, which depends on the combined action $2ZnS + Fe_2O_3 + 3CO = 3CO_2 + 2Fe + 2ZnS = 3CO_2 + 2FeS + 2Zn$, by mixing the zinc blende with finely-divided iron. At 1,800° ZnS is practically completely reduced by this means. The presence of Fe_2O_3 is prejudicial to this process, but of FeO is not. The heating must be carried out in the absence of all gas but Zn vapour, and an electrical method is preferred. F. R.

747. *Nitrogen in Iron.* **H. Braune.** (Stahl u. Eisen, 26. pp. 1357–1363, Nov. 15; 1431–1437, Dec. 1, and pp. 1496–1499, Dec. 15, 1906.)—Further experiments showing the percentages of nitrogen in various materials: Grey pig, 0·007–0·015; Swedish ditto, 0·002–0·020; white pig, 0·021–0·040; ditto, for Thomas process, 0·02–0·08; ditto, for basic, Siemens-Martin, 0·025–0·085; ditto, for puddling, 0·03–0·035; ditto (Swedish), 0·003–0·020; "washed" pig, 0·035–0·050; puddled iron, for wire manufacture, 0·025–0·030; best Swedish iron, 0·006–0·008; acid, Siemens or Bessemer steel, 0·006–0·018; basic Siemens steel, 0·020–0·025; Swedish crucible steel, 0·006; crucible steel, not Swedish, 0·015–0·020. It is said that the effect of the presence of slag particles in the metal is to hinder the harmful effects of nitrogen. [See also Abstract No. 2119 (1905).] F. R.

748. *Blow-holes in Steel Ingots.* **A. Ruhfus.** (Stahl u. Eisen, 26. pp. 775–777, 1906.)—The smaller an ingot or casting, and the more rapidly it is cooled, the more gas it is found to retain. Quenched samples, taken at various stages during the heat in a Siemens-Martin furnace, show that as the temperature of pouring increases, the blow-holes tend to occur more numerously towards the centre of the ingot, gradually becoming smaller and fewer in other regions. F. R.

749. *Production of Malleable Nickel.* **E. S. Sperry.** (Metallurgie, 4. pp. 155–156, March 8, 1907. From The Brass World, Jan., 1907. Abstract.)—The Ni should be as free as possible from carbon, in order to arrive at a good degree of malleability. Any of the usual forms of Ni is melted in a carbonless crucible with about 1 per cent. Mn; no flux nor stirring is necessary. Further procedure is as usual, the metal being worked either in the hot or cold state. The original article is illustrated, and the author discusses the literature of the subject. F. R.

750. *Use of Metallic Deposits in Micrography.* **F. Giolitti.** (Gazzetta Chim. Ital. 36. 2. pp. 142–147, 1906.)—The metallic deposit upon a polished alloy, whether obtained electrolytically or without the aid of a current, is usually of a different nature upon the different constituents. Differences are also brought about by polishing the deposit partially away, and by etching it. Results obtained with normal and treated steels are described, and it is shown to be possible to distinguish the constituents by these means. For example, in a low-carbon steel used as kathode in a 0·2 to 0·5 per cent. solution of $CuSO_4$ for a short time and afterwards lightly polished, the granular structure of the ferrite, and also the structure of pearlite, showed up prominently. Upon immersion of a piece of the same steel in $CuSO_4$ solution without a current, Cu was deposited on ferrite only. F. R.

751. *Periodic Phenomena in Crystallisation.* **D. Alexieff.** (Jurn. Russk. Fisik.-Chimičesk. Obščestva, 38. pp. 1120–1123, 1906.)—When molten tetraethyl ethanetetracarboxylate is spread out in a thin layer, solidification begins at a centre and then proceeds in concentric zones, which widen periodically. If a thin layer of the supercooled ester is seeded with a crystal of the same substance, crystallisation takes place radially from the nucleus for some time, after which the separation of crystals ceases for a period, then proceeds more rapidly, and so on. Examination of the zones in polarised light shows that each zone is bounded by a sharp edge, of which only certain points act as centres of crystallisation for the succeeding zone. The formation of these zones and the subsequent halting of the crystallisation are regarded as due to changes produced in the surface tension of the liquid by the heating which follows crystallisation. The greater surface tension of the supercooled layers causes the liquid to separate from the crystallising portion, just as water is driven from a drop of alcohol. Similar results were obtained with supercooled benzophenone and coumarin. T. H. P.

752. *Explosive Combustion of Hydrocarbons.* II. **W. A. Bone, J. Drugman, and G. W. Andrew.** (Chem. Soc., Journ. 89. pp. 1614–1625, Nov., 1906.)—In the propagation of a flame through mixtures of ethane or ethylene with oxygen in the proportions $C_2H_6 + O_2$ or $3C_2H_4 + 2O_2$, the products formed during the early stages of the combustion are mainly water vapour, aldehyde, ethylene, and acetylene, whilst carbon is a later product. Water vapour is rapidly decomposed by carbon at a high temperature, so that, the longer the duration of the flame, the less the amount of steam in the final products. Detonation experiments with mixtures of oxygen and ethane $(C_2H_6 + O_2)$ or butane $(C_4H_{10} + 2O_2)$ at initial pressures of 900 mm. and upwards indicate that the mechanism of combustion in this case is essentially the same as in ordinary combustion. [See also Abstract No. 1958 (1906).] T. H. P.

753. *Use of Electrolytic Oxygen with Berthelot's Calorimetric Bomb.* **P. W. Zuboff.** (Jurn. Russk. Fisik.-Chimičesk. Obščestva, 38. pp. 1123–1128, 1906.) —The author's experiments, in which oxygen containing varying proportions of hydrogen was employed, show that only that part of the hydrogen mixed with the oxygen actually used up in the calorimetric bomb undergoes combustion. The correction applied by Berthelot [Abstract No. 642 (1903)] when electrolytic oxygen, containing small quantities of hydrogen, is employed in the calorimetric bomb, must hence be reduced to about 20 per cent. of the value given. T. H. P.

754. *Connection between Nernst's Assumption and Kopp's Law.* **F. Jüttner.** *Remarks thereon.* **O. Sackur.** (Phys. Zeitschr. 8. pp. 147–150, March 1, 1907.) —To determine the constant C in the integral equation connecting the maximum work A with the heat-development Q in chemical reactions, viz., $A/T = C - \int (Q/T^2)dT$, Nernst assumes that $(dA/dT)_{T=0} = (dQ/dT)_{T=0}$ [see Abstract No. 580 (1907)]. Now, Kopp's law regarding molecular heats gives $(dQ/dT)_{T=0} = 0$, and this, being by the above equation equivalent to $(Td^2A/dT^2)_{T=0} = 0$, is compatible with a finite value of $(dA/dT)_{T=0}$; hence

Nernst's assumption is really a double one, viz., the validity of Kopp's law and the vanishing with T of the function dA/dT, which with the hypotheses of Brönsted and others would be infinitely large at absolute zero temperature. Sackur points out that, as dA/dT measures the variation of the entropy, Nernst's second assumption is that no variation of entropy accompanies any isothermal reactions at zero temperature. R. E. B.

755. *Conductivity and Viscosity of Solutions of Salts in Binary Mixtures of Water, Methyl Alcohol, Ethyl Alcohol, and Acetone.* **H. C. Jones, E. C. Bingham,** and **L. McMaster.** (Amer. Chem. Journ. 36. pp. 325–409, Oct., 1906. Zeitschr. Phys. Chem. 57. pp. 193–248, Nov. 20, and pp. 257–320, Dec. 11, 1906.)—Lithium bromide and cobalt chloride exhibit at intermediate compositions of the solvent minimum values for the electrical conductivity when dissolved in mixtures of water with the alcohols or with acetone; the minimum is most pronounced at low temperatures and is closely related to the minimum fluidity which occurs in mixtures of the above solvents. Mixtures of the alcohols with one another exhibit a linear relationship between fluidity and percentage composition. In accordance with this observation, lithium bromide gives a linear relationship between conductivity and the composition of the solvent; cobalt chloride gives curves which are approximately linear, but sag slightly. Mixtures of acetone with the alcohols give linear relationships between conductivity and composition, and this is also true when lithium bromide is added to the mixtures. But the conductivities of the lithium solutions exhibit a pronounced maximum at intermediate compositions of the solvent, and this is attributed to a decrease in the amount of solvent combined with the ions of the solute. The temperature-coefficients of conductivity are positive for all the lithium bromide solutions and are of the same order of magnitude as the fluidity-coefficients. The solutions of cobalt chloride in acetone mixtures show, however, in some cases negative temperature-coefficients of conductivity, although the fluidity-coefficients remain positive. Zero coefficients were also observed in certain cases corresponding with the maxima observed by other workers in the case of certain non-aqueous solutions at high temperatures. T. M. L.

756. *Relative Migration Velocities of the Ions of Silver Nitrate in Binary Mixtures of Water, Methyl Alcohol, Ethyl Alcohol, and Acetone.* **H. C. Jones** and **C. A. Rouiller.** (Amer. Chem. Journ. 36. pp. 427–487, Nov., 1906.)—Measurements were made of the conductivity of silver nitrate dissolved in acetone and in binary mixtures of acetone with water, methyl alcohol, and ethyl alcohol, and the transport numbers for the anion were determined at 0° and at 25°. In accordance with earlier observations, it was found that as a rule the relative velocity of the slower ion increases with the temperature, but exceptions occur in certain cases. The relative migration-velocities vary considerably with the nature of the solvent; thus the transport numbers for the anion are at 0°, 0·555 for solutions of silver nitrate in water, 0·561 in methyl alcohol, 0·621 in ethyl alcohol, and about the same in acetone. These variations are attributed to variations in the relative amounts of solvent combined with the two ions. T. M. L.

757. *Laws of the Reciprocal Action of Solid Substances in Cryohydrate Mixtures and in Eutectic Alloys.* **F. M. Flawitzky.** (Jurn. Russk. Fisik.-Chimičesk. Obščestva, 37. pp. 862–875, 1905.)—The author deduces the following relations between the compositions and solidifying points of

cryohydrate or eutectic mixtures and the solidifying points of their components. (1) *Law of Equal Molecular Freezing-point Depressions.*—Assuming that the molecular freezing-point depressions of each of two substances in the other are equal, as is often the case, it is shown that the ratio between the amounts of the two present in the eutectic mixture is represented by the expression: $n_0 = \sqrt{M_1T_1}/\sqrt{M_0T_0}$, where T_0 and T_1 are the differences between the freezing-point of the eutectic mixture and those of the two components having the molecular weights M_0 and M_1, and n_0 the ratio between the percentage contents of the second and first of the two compounds present in the mixture. (2) *Law of Multiple Molecular Depressions.*—When, however, the two substances with molecular weights of M_0 and M_1 occur in the solid form in a polymerised or associated state, the association factors being p and q, the relation becomes $n_0 = \sqrt{qM_1T_1}/\sqrt{pM_0T_0}$, from which the association ratio $p:q$, can be calculated. (3) *Law of the Equivalence of Molecular Freezing-point Depressions.*—This law states that the degree of polymerisation is a characteristic constant for any substance and remains unchanged in binary mixtures. T. H. P.

758. *Spinodal and Plait-point Curves for Binary Mixtures of Normal Substances.* **J. J. van Laar.** (Konink. Akad. Wetensch. Amsterdam, Versl. 15. pp. 227–236, Oct. 10, 1906. Proc., 9. pp. 226–235, Oct. 25, 1906.)—The author briefly reviews his former papers. I. [Abstract No. 1831 (1905)]. The equations for the spinodal lines of normal substances are developed. II. [Abstract No. 1832 (1905)] The shape of the lines is treated with certain modifications, and it appears that the abnormal cases found by Kuenen can exist for mixtures of perfectly normal substances. III. [Abstract No. 228 (1906)] A general equation was obtained for $\pi = 1$. IV. (Archives Teyler, Nov., 1905). More general. V. [Abstract No. 1167 (1906)] Gives relations for minimum critical temperature. VI. (Archives Teyler, May, 1906) Examines more carefully into the connodal relations. The present paper shows that the three types can be divided by the relations between θ and π, the type I. appearing with given π when θ is comparatively large. The differentiation between types II. and III. is only made for special cases. Results show that the abnormal type III. is possible for mixtures of normal substances, and in general it may be supposed that these results are qualitatively accurate although further elaboration would change them numerically. H. H. F. H.

759. *Relation of Solution Pressure to Surface Condition in Metals.* **C. E. Fawsitt.** (Soc. Chem. Ind., Journ. 25. pp. 1183–1184, Dec. 15, 1906.)—The different rates of solution of various kinds of iron observed by Burgess and Engle [see Abstract No. 158 (1907)] may solely be due to differences in the surface condition, which are best investigated by potential determinations of the metals in aqueous solutions of their salts. The author [see Abstract No. 1144 (1906)] uses rods, 4 in. in length, ¼ in. diam., covered all over except for a small part with wax, and rotates the rods 6 times per sec. in order to obtain constant values. The potentials of different irons, from the purest iron to steel with 0·9 per cent. of carbon, vary only between −0·082 and −0·076 volt; this is the potential of the ferrite in the iron, the cementite being of little influence. Silver in silver nitrate gives the following potentials, always against a normal calomel kathode: Brightly polished +1·055, the same annealed by red heat 1·066, same hammered hard 1·057 volts; gold in gold chloride under similar conditions, +1·447, 1·454, 1·422 volts. The hardened amorphous variety (Beilby) gives a higher solution pressure than the softer

crystalline variety; polishing produces a hard surface film which is very thin in the case of gold. Further, a rough surface has a higher potential than a smooth surface. This is shown for different varieties of iron in solutions of ferrous sulphate, where the potential is negative, and in ferric chloride, where the potential of the iron is positive. In the chloride pure compact iron shows +0·129 volt polished, and 0·128 rubbed with emery; electrolytic iron fresh from the bath 0·040, heated gently in hydrogen 0·121, heated red-hot in hydrogen 0·138; steel (polished) 0·146, steel (pumice blasted) 0·118 volt. That roughening, by etching or blasting, produces a higher solution pressure may be due to the greater number of points exposed to the liquid. Electrolytic iron is crystalline and should therefore have a small solution pressure; but as many points are exposed, the pressure should be large; the latter, opposite effect is reduced by heating when the iron shrinks. (*Erratum*, Ibid. 26. p. 8, Jan. 16, 1907.) H. B.

760. *Limited Miscibility of Liquids; the System: Diphenylamine—Carbon-Dioxide.* **E. H. Büchner.** (Zeitschr. Phys. Chem. 56. pp. 257–318, July 31, 1906. Anorgan. Chem. Laborat. d. Univ., Amsterdam.)—The earliest investigation on non-miscible liquids was made by Alexejew (1886). Since then work has been confined to investigating the influence of temperature, leaving that of pressure quite out of consideration. The author first treats the equilibrium of fluid phases only, at constant temperature, giving diagrams. The case of varying temperature is divided into three classes. In (1) the miscibility increases with falling temperature and two "critical end-points" are found, these being the common points in the p.t. projection between the critical and the three-phase curves. The relation given by Ostwald between the two critical points (gas-liquid) and (liquid-liquid), that the latter has one more degree of freedom than the former, is found to really apply to the critical and critical end-points. In (2) the miscibility increases with increasing temperature, and the two liquids become identical. There is one critical end-point ($L_1 = L_2$). Case (3), where one liquid phase becomes identical with the vapour, has also one critical end-point where ($b = L_1$). This case is little known, and only the systems ether-water above 190°, ethane-water, and SO_2-water can be safely classed with it. Various examples of the other cases are given. The equilibrium with a solid phase present is then investigated; numerous diagrams are given for the above three types and, further, for the case that the two three-phase lines become continuous. Experimental work was carried out in the usual Cailletet tube provided with magnetic stirrer and immersed in a 12-litre water-bath, the temperature of which was controlled by toluene regulator. Pressures were read on an air manometer. The purest diphenylamine was recrystallised from alcohol and ligroin until the melting-point remained constant at 52·8°. Fused sodium carbonate and sulphuric acid in a perfectly air-free apparatus gave pure CO_2. The experimental tube was pumped to vacuum 12 times and filled with gas dried over sulphuric acid. The two three-phase curves and a critical end-point were determined, and had the expected values. Further experiments showed that the miscibility decreases with rising temperature. H. H. F. H.

761. *Three-phase Lines in Chloral Alcoholate and Aniline Hydrochloride.* **H. W. Bakhuis Roozeboom.** (Konink. Akad. Wetensch. Amsterdam, Versl. 15. pp. 58–64, July 20, 1906. Proc., 9. pp. 99–104, Aug. 21, 1906.)—These substances were chosen for their comparatively low melting-points and because a minimum pressure might be predicted. In the first case the minimum is very close to one melting-point. In the second the first maximum occurs at too high a pressure to be determined; the second maximum is on the side of the aniline. The sublimation line was also determined. Diagrams and figures are given, and it is noted that this is the first instance of the verification of the normal course of the p.t. lines in a pure compound which dissociates slightly. H. H. F. H.

762. *Precipitate Membranes in Jellies: Constitution of Gelatine Jellies.* **H. Bechhold** and **J. Ziegler.** (Ann. d. Physik, 20. 5. pp. 900–918, Sept. 14, 1906.)—A thin precipitate membrane of, for instance, silver chloride or barium sulphate in gelatine is permeable to the salt solutions from which it is formed, if there is a higher osmotic pressure on one side of the membrane than on the other; the membrane then increases in the solution of lower osmotic pressure. If, however, the osmotic pressures on the two sides of the membrane are equal, diffusion of the salt solutions is prevented. A melted silver chloride or barium sulphate membrane in gelatine does not prevent the diffusion of salt solutions; the one of the latter having the lower osmotic pressure diffuses through the membrane into the solution with the higher osmotic pressure. A precipitate membrane of copper or zinc ferrocyanide produced in gelatine is impermeable for potassium ferrocyanide. These observations are best explained by regarding a gelatine jelly as a network of gelatine poor in water, surrounded by a solution rich in water and poor in gelatine. The electrolytes use only the latter as a path for diffusion, and if this path is blocked by a precipitate, diffusion is hindered or prevented. [See also Abstract No. 334 (1907).]

T. H. P.

763. *Settling of Suspensions.* **E. Buckingham.** (Amer. Electrochem. Soc., Trans. 9. pp. 265–276, 1906.)—The author puts forward a theory, according to which the addition of an electrolyte to a pure liquid, with consequent increase in the concentration of free adsorbable ions, causes: (1) an increase of the suspending power, *i.e.*, of the time during which the given suspension will remain suspended in the liquid, proportional to the concentration, and (2) an annihilation of this effect, increasing with some higher power of the concentration and tending finally to reduce it to zero, or to reduce the suspending power of the liquid to its initial value. Preliminary experiments lend support to the theory.

T. H. P.

764. *Influence of Strong Electrolytes on Distribution Phenomena.* **H. M. Dawson.** (Zeitschr. Phys. Chem. 56. pp. 605–611, Sept. 7, 1906.)—As bearing upon recent work on the solvent power of solutions, attention is called to the author's observations on the influence of salts on the distribution of ammonia between chloroform and water, the effect in almost every case being to decrease the concentration in the solution. Similar results are also given for the distribution of iodine between carbon disulphide and aqueous solutions. It is shown that the effects produced by different salts are in the same order in the two cases, though they are not quantitatively proportional; the general character of the results is also similar to that of the observations made in studying the solubility of substances such as hydrogen, carbon dioxide, nitrous oxide, oxygen, hydrogen sulphide, phenylthiocarbamide, ethyl acetate, and ether in aqueous solutions of strong electrolytes. [See also Abstract No. 1974 (1906).] T. M. L.

765. *The Self-movement of the Particles in Colloidal Solutions.* Parts I and II. **T. Svedberg.** (Zeitschr. Elektrochem. 12. pp. 853–860, Nov. 23, and pp. 909–910, Dec. 21, 1906. Chem. Universitätslaborat., Upsala, Sept.–Oct., and Dec., 1906.)—I. The author has, with the aid of the ultramicroscope, made a quantitative examination of the movements of colloid particles of platinum, of calcium, and of sodium. The platinum sol was formed and examined in presence of different solvents (acetone, water, glycerine, &c.), and the dependence of the amplitude of vibration of the particles on the viscosity was established; a graphic representation of the results is of hyperbolic form. The absolute velocity of the platinum particles in different solvents was found to be approximately constant $= 2{\cdot}4 \times 10^{-3}$ cm./sec., though the time of vibration became steadily less as the amplitude diminished. II. The author has since ascertained that a mathematical theory of the Brownian movements has been already published by A. Einstein [Abstracts Nos. 1909 (1905) and 748 (1906)]. The author now shows that his data are in accordance with Einstein's formulæ. D. H. J.

766. *Electrolytic Estimation of Copper.* **F. Foerster.** (Ber. Deut. Chem. Gesell. 39. pp. 3029–3035, 1906.)—The substitution of a wire-net kathode for the ordinary massive platinum one renders the addition of nitric acid to the copper solution unnecessary. With an e.m.f. of about 1·7–2 volts copper may be precipitated quantitatively from its sulphate in dilute sulphuric acid solution, even in the presence of Cd, Zn, Ni, Co, and Fe, since these metals require more than 2 volts for their deposition. An ordinary lead accumulator may be employed with an electrolytic cell, consisting of a glass beaker fitted with a wire-net kathode and a platinum spiral anode. Each cell requires at the commencement only 0·12 amp., so that several may be connected in parallel, and the depositions when started overnight are complete next morning. The time required may be much reduced by the use of a hot electrolyte, 0·15 gm. Cu being deposited in about 1 hour from sulphuric acid at 75° C. with an e.m.f. of 2 volts. Neither ammeter nor regulator is required by this method, the deposition being complete as soon as the evolution of oxygen at the anode ceases. W. H. Si.

767. *Electrolytic Production of Hydrogen Peroxide.* (Brit. Pat. 24,507 of 1905.)—G. Teichner prepares hydrogen peroxide from persulphuric acid or its sulphuric acid solution, either by distillation *in vacuo* at a temperature exceeding 80° C., care being taken to exclude catalytic agents, or by extraction with ether in a continuous extraction apparatus. The solution freed from hydrogen peroxide is then electrolysed to reproduce persulphuric acid, the latter simply acting as a transmitter of oxygen, and hydrogen peroxide being obtained by indirect oxidation of water. Percarbonates and perborates yield hydrogen peroxide on similar treatment. W. H. Si.

768. *Electrolysis of Iodine–Potassium-Iodide.* **E. Brunner.** (Zeitschr. Phys. Chem. 58. pp. 1–126, Feb. 19, 1907. Habilitationsschrift, Stuttgart.)—Further particulars and continuation of the researches, mentioned in Abstract No. 1949 (1906), and undertaken with the object of deciding whether the kathodic reduction of iodine to iodine-ion, and the anodic oxidation of iodine-ion to iodine, is for every voltage purely a diffusion process, and the polarisation merely a concentration polarisation. By polarisation ϵ the author understands the p.d. between the observation electrode and an auxiliary electrode of the same material, platinum, dipping into the electrolyte, but not joined to the circuit. The arrangements are as in the previous paper. Only for solutions which contain very little iodine is the observed polarisation current ϵ equal to the current calculated on the above-mentioned assumption; in most cases the relation holds: $\epsilon_{\text{obs.}} = \epsilon_{\text{calc.}} + J[w_0 + f(d\epsilon/dJ)]$, where J is the current intensity and the bracket indicates the author's apparent resistance. This resistance consists of the resistance proper w_0, determined by means of alternating currents, and the function $d\epsilon/dJ = w_1$, which, for a given conductance of the electrolyte, depends only upon the differential quotient; w_1 varies with the size of the observation electrode between 0·1 and $8w_0$. The experiments were chiefly made with platinised Pt; the limiting current is the same with smooth and with platinised Pt electrodes, and there is apparently not any "Überspannung" in either case. As the reaction $2I' + 2\oplus \rightleftharpoons I_2$ is not retarded by slowly-proceeding chemical changes, it seems to be a direct process which does not depend upon the intercession of hydrogen and oxygen. Similarly the reductions and oxidations of Sackur and of Fredenhagen need not be due to hydrogen and oxygen. In applying the law of mass action the reactions must not be assumed to occur in a space of constant concentration; they are not confined to layers of molecular dimensions, and penetrate into the electrodes and catalysers. As regards his controversy with Ericson-Aurén and Palmaer, concerning the velocity of the dissolution of zinc in acids, the author retracts certain statements, but holds that when metals come in contact with acids, hydrogen may be evolved at any spot where the "Überspannung" is sufficiently small, no matter whether or not metal is dissolved at that particular spot; anode and kathode may more or less coincide in space. A fuller account of the experiments made with smooth Pt electrodes is to follow. H. B.

REFERENCES.

769. *Density of Gaseous Hydrogen Chloride: Atomic Weight of Chlorine.* **P. A. Guye** and **G. Ter-Gazarian.** (Comptes Rendus, 143. pp. 1233–1235, Dec. 31, 1906.)—The weight of 1 litre of hydrogen chloride at 0° and 760 mm. is found to be 1·6398 gm., which gives 36·469 as the molecular weight of hydrogen chloride and 35·461 as the atomic weight of chlorine. This value agrees well with that obtained from Dixon and Edgar's results [Abstract No. 443 (1906)] and with that derived from the Ag : Cl ratio and the atomic weight of silver [Abstract No. 335 (1907)], but the authors do not regard it as a final value. T. H. P.

770. *Experiments on Ultramicroscopic Determination of Solubility.* **W. Biltz.** (Zeitschr. Phys. Chem. 58. pp. 288–292, March 5, 1907. Communication from the chem. Laborat. d. Bergakademie, Clausthal.)—By determining by means of the ultramicroscope the dilution at which solutions capable of producing a precipitate can be mixed without particles appearing in the liquid, the author has obtained values for the solubility of several sparingly soluble salts, which agree fairly well with the values obtained by the conductivity method. A. F.

771. *Lead-Thallium Alloys.* **K. Lewkonja.** (Zeitschr. Anorg. Chem. 52. 4. pp. 452–456, Feb. 22, 1907. Metallog. Communication from the Inst. f. anorgan. Chemie d. Univ., Göttingen.)—The author's results are similar to those of Kurnakow and Puschin [see Abstract No. 738 (1907)], with the principal difference that the maximum at about 35 per cent. Pb (373·7°) is ascribed to the presence of the compound $PbTl_2$. F. R.

772. *Unsolved Problems in Metallurgy.* **R. A. Hadfield.** (Inst. Civil Engin., Proc. 166. pp. 190–223, 1905–1906. "James Forrest" Lecture. Electrician, 57. pp. 133–134, May 11, 1906. Engineering, 81. pp. 601–603, May 4, and pp. 634–635, May 11, 1906.)